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TF 2010

Double Pulse Generator

INSTRUCTION MANUAL

MP MASTER
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MARCONI INSTRUMENTS LIMITED

GEC-Marconi
AVIONICS

CENTRAL QUALITY DEPARTMENT

STANDARDS LABORATORIES

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TECHNICAL DATA AND SPECIFICATION OF THIS INSTRUMENT CAN BE FOUND IN SECTION.....1.....OF THIS MANUAL.

OPERATING INSTRUCTIONS CAN BE FOUND IN SECTION...2..OF THIS MANUAL.

PERFORMANCE CHECK/CALIBRATION CAN BE FOUND IN SECTION...3....OF THIS MANUAL.

STANDARDS USED: STD30, STD27, STD270, STD53.

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Chapter 1

General information

1.1 INTRODUCTION

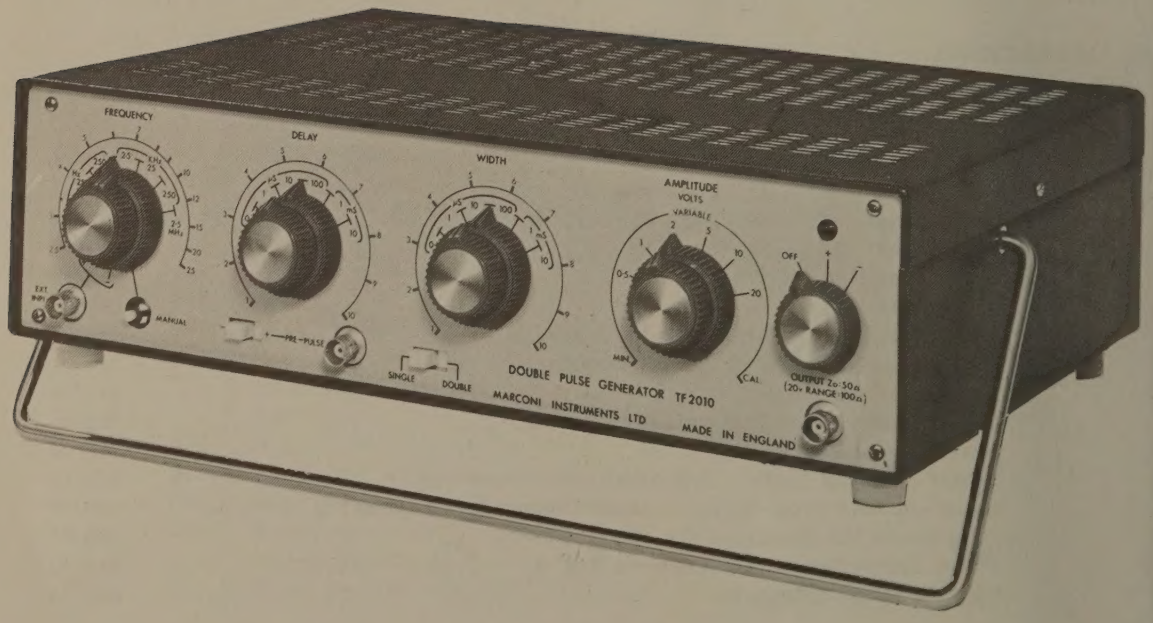
The TF 2010 functions either as a double pulse generator within the range 2.5 Hz to 2 MHz or as a single pulse generator within the range 2.5 Hz to 2.5 MHz. Pulse-width and amplitude are variable and positive or negative polarity may be selected for the output.

In each cycle a 'pre-pulse' of selectable polarity is produced before the main pulse/s. The duration between the 'pre-pulse' and main pulse (on single pulse mode) or between the two main pulses (on double pulse mode) may be varied by use of a Delay control.

The instrument may be triggered by the internal variable frequency oscillator (free running operation), by depression of a push-button (single shot), or by the application of external signals (single shot or repetitive operation).

Silicon semi-conductor devices are employed throughout this compact pulse generator, which is designed for mains operation.

The front and rear panels of the instrument are recessed in the dual-sectioned case. The unit is fitted with an adjustable stand which may be used alternatively as a carrying handle.



1.2 DATA SUMMARY

1.2.1 Power Supply

100 - 125 V, 50 - 60 Hz or 200 - 250 V, 50 - 60 Hz.
(Voltage selection by internal adjustment; see Sect. 2.1).
Consumption approximately 35 W.

1.2.2 Frequency

2.5 Hz to 2.5 MHz, single pulse mode.
2.5 Hz to 2 MHz, double pulse mode.
The frequency is continuously variable within each of the following six ranges.

Range 1:	2.5 Hz	to	25 Hz
Range 2:	25 Hz	to	250 Hz
Range 3:	250 Hz	to	2.5 kHz
Range 4:	2.5 kHz	to	25 kHz
Range 5:	25 kHz	to	250 kHz
Range 6:	250 kHz	to	2.5 MHz

Calibration accuracy:

Range 1: 15% over entire scale.
Ranges 2-6: 5% at extremities of scale.
10% at intermediate calibrations.

1.2.3 Main Pulses

Polarity: Positive or negative with respect to chassis-earth.

Amplitude: 20 V, maximum. Continuously variable within each of the following ranges.

0.5 V, 1 V, 2 V, 5 V, 10 V, 20 V.
(Voltage figures for no-load condition)

Calibration accuracy: (with Amplitude variable control set to 'CAL)

0.5 and 1 V ranges: 10%.
other ranges: 5%.

Rise and fall times:

Leading edge: 10 ns.
Trailing edge: 15 ns.

Nominal value between 10% and 90% points of output amplitude.

Pulse widths: 100 ns to 10 ms in five decade ranges. Continuously variable within each range.

Calibration accuracy: 5% at extremities of scale (each range).
10% at intermediate calibrations.

Output impedance: 100 Ω on 20 V amplitude-range:
50 Ω on all other ranges.

1.2.4 Delay

Variable range: 100 ns to 10 ms in five decade ranges.
Continuously variable within each range.

Calibration accuracy: 5% at extremities of scale (each range).
10% at intermediate calibrations.

Single pulse mode: Main pulse delayed with respect to the pre-pulse by a fixed time (typically 50 ns) plus the Delay control setting.

Double pulse mode: The first Main Pulse is delayed with respect to the pre-pulse by a fixed time, typically 50 ns. The second Main Pulse is delayed with respect to the first Main Pulse by the Delay control setting.

On Delay range '0.1-1 μs', Delay variable-control settings of less than '2' are not valid in the double pulse mode. Therefore, the minimum selectable delay is 200 ns.

1.2.5 Pre-Pulse

Polarity:	Positive or negative (Output a.c. coupled)
Amplitude:	7.5 V ±2.5 V (unloaded)
Pulse-width:	Between 100 and 250 ns.
Output impedance:	Not greater than 1 kΩ.

1.2.6 Trigger Signals

Trigger modes, (selected by the 'Frequency' switch):

Internal

External

Manual (push-button)

External Trigger Signal Specification:

(D.C. coupled input)

Waveform: Sinewave, squarewave or pulse.

Amplitude: 3 V to 50 V peak.

Frequency: D.C. to 2.5 MHz.

Trigger Level: 3 V positive or negative polarity (selectable at the Frequency switch).

Pulse Width: 100 ns.

Input Impedance: Approximately 10 kΩ.

1.2.7 Weight and Case Dimensions

Width	Height	Depth (front to rear)	Weight
360 mm (14 $\frac{1}{4}$ in)	100 mm (3 7/8 in)	270 mm (10 $\frac{1}{2}$ in)	5.5 kg. approx. (12 lb)

1.3 ACCESSORIES

Accessories supplied: 2 free B.N.C. plugs (50 Ω).

Chapter 2

Operation

2.1 MAINS-VOLTAGE SETTING

Before a mains supply is connected to the instrument, check that the tapping selected on the internal mains transformer is suitable for the supply voltage.

To gain access to the transformer, remove both sections of the case which are secured by two screws, one at each side of the instrument. The transformer is mounted in the left-hand rear corner behind the Frequency controls.

Mains tappings on the transformer are accessible from the left-hand side of the instrument. The wire connected to the 0 V tag should not be removed since this is the neutral supply line. The white wire, the live line, is provided as the movable lead which should be soldered to the tap most suitable for the supply voltage.

Mains connections are provided on the transformer as indicated below.

	0 V
205 V	102 V
225 V	112 V
245 V	122 V

--- transformer base ---

Replace and secure the case before connecting the mains supply.

2.2 CONNECTION OF MAINS SUPPLY

Having checked the voltage-setting of the mains transformer (Sect. 2.1), set the output polarity switch, situated below the red indicator lamp, to the OFF position. Connect the supply to the 3-core mains-lead as follows.

Brown core	:	Mains live
Blue core	:	Mains neutral
Green/yellow core	:	Earth

2.3 CONNECTION OF SIGNAL LEADS

Prior to the insertion of signal leads, check that the stand is situated below the level of the three front-panel-mounted connectors. Each connector is a coaxial socket type BNC. The PRE-PULSE output socket is mounted near the middle of the panel with the 'Main-Pulse' OUTPUT socket on the right. Use of the EXTernal INPUT socket (to the left of the panel) is required only when the instrument is to be triggered by external signals.

2.4 PRELIMINARY TESTS

It is recommended that, prior to general use of the instrument, a test be made to check the basic operation following transit. To conduct the test, terminate the main-pulse output in a 100 Ω resistor

and connect one vertical channel of a double beam oscilloscope so as to observe the signals developed across the load: connect the other vertical channel to the Pre-Pulse socket.

Set the controls as indicated below.

Control		Setting
Frequency switch	:	25 - 250 kHz
Frequency variable control	:	10
Delay switch	:	1 - 10 μS
Delay variable control	:	2
Width switch	:	0.1 - 1 μS
Width variable control	:	5
Amplitude switch	:	20
Amplitude variable control	:	CALibrated
Pre-Pulse switch	:	+
Single/Double mode switch	:	Double
Supple/Pulse polarity switch	:	+

Check that two 10 V positive pulses, each of width 0.5 μS and spaced 2 μS apart (i.e. between the leading edges), are produced after each pre-pulse. The pre-pulse should be a positive pulse of approximately 7.5 V amplitude. The pre-pulse repetition frequency should be 100 000 pulses per second.

2.5 NORMAL OPERATION

2.5.1 Supply and Main-Pulse Polarity Switch

The mains supply is disconnected from the internal circuit when this switch (mounted on the right of the panel) is set to the 'OFF' position.

Switch ON the supply by turning the control to:

' + ', (for main pulses to be positive with respect to chassis-earth) or

' - ', (for main pulses to be negative with respect to chassis-earth).

With the switch set to either of the above position (+ or -), the red supply-indicator lamp, mounted above the switch, should be illuminated.

2.5.2 Mode Selector

The two-position slide-switch mounted approximately midway along the lower part of the front panel and marked 'Single-Double' serves as a mode selector. The setting of the switch indicates the number of 'main pulses' generated after each 'pre-pulse'.

2.5.3 Pre-Pulse Output

A two-position slide-switch and an a.c. coupled coaxial socket are provided for the Pre-Pulse output; they are mounted below the Delay controls.

The switch serves as pre-pulse polarity selector. The pre-pulse is negative going when the switch is in the ' - ' position and positive going when the switch is in the ' + ' position.

2.5.4 Frequency and Trigger Selector

The dual control marked 'Frequency' serves as both trigger and frequency selector.

Manual Trigger:

The outer control (a large knob, with T-shaped panel markings) is a ten-position switch. Manual trigger operation is selected when the switch is set to the first position (i.e. the extreme anti-clockwise setting). The instrument is then triggered, for single shot operation, each time that the Manual push-button is depressed. With this switch setting the inner control is inoperative.

External Trigger:

When the outer control is set to the second or third position, the instrument is triggered by signals applied at the socket marked EXT. INPUT (see Sect. 1.2.6). The inner control is inoperative on each of these switch settings.

The pulse generator is triggered by:

(i) Negative going external input signals when the switch is set to ' - ' (i.e. the 2nd position).

(ii) Positive going external input signals when the switch is set to ' + ' (i.e. the 3rd position).

Before using the External Trigger facility refer to Note 2 below.

Internal Trigger:

Should the switch (outer Frequency control) be set to the unmarked fourth position no output signals will be produced.

For internal trigger operation, the band 2.5 Hz to 2.5 MHz is covered in six consecutive ranges by the fifth to tenth positions of the switch. For each range, the inner control (a small knob, with black panel markings) serves as a variable frequency control.

Example of Control Operation:

With the switch set to the seventh position, the figures (250 Hz) to the left of the T-shaped position-mark indicate the lower limit of the selected frequency range, whilst those to the right (2.5 kHz) indicate the upper frequency limit. In this case the lowest calibration mark (2.5) of the inner control corresponds to 250 Hz, whilst the highest calibration mark (25) corresponds to 2.5 kHz. Any trigger frequency between these limits may therefore be selected by the use of this inner control.

NOTES: (1) With the 250 kHz - 2.5 MHz frequency range selected for use in the Double Pulse mode, the output pulse specification (Sect. 1.2.3) may not be valid for variable-frequency-control settings greater than 20 (i.e. 2 MHz, see Sect. 1.2.2).

(2) For Single or Double Pulse mode, the interval between consecutive trigger signals, i.e. the reciprocal of the Frequency setting in the case of internal trigger operation, should not be less than the Delay setting or the Pulse Width setting.

2.5.5 Delay Control

In the Double pulse mode, the setting of the dual control marked 'Delay' indicates the duration between the leading-edge of the first 'main pulse' and the leading-edge of the second 'main pulse' generated in each cycle.

For the Single pulse mode, the duration between the leading-edge of the 'pre-pulse' and the leading-edge of the 'main pulse' in each cycle is approximately 50 ns plus the time indicated by the Delay control setting.

Delay times of 0.1 μs to 10 ms are covered in five consecutive ranges by the outer control (a large knob, with T-shaped panel-markings). For each range the inner control (a small knob, with black panel-markings) serves as a variable control. Thus, with the outer control set to the fourth position, the variable control may be used to select any delay time from 100 μs (corresponding to panel-mark ' 1 ') to 1 ms (corresponding to panel mark '10'. For correct operation note that,

(1) for the Single pulse mode, the Delay setting or Width setting should be less than the interval between consecutive trigger signals, i.e. the reciprocal of the Frequency setting in the case of internal trigger operation.

(2) for the Double pulse mode, the Delay setting should be less than the interval between consecutive trigger signals and the Width setting should be less than the Delay setting.

2.5.6 Width Control

The setting of the dual control marked 'Width' indicates the duration of each 'main pulse'. This control is physically identical to, and may be set in the same manner as, the Delay control. For correct operation note that,

(1) for the Single pulse mode, the Width setting should be less than the interval between consecutive trigger signals.

(2) for the Double pulse mode, the Width setting should be less than the Delay setting.

2.5.7 Amplitude Control

The amplitude of each 'main pulse' is dependent upon the setting of the dual control marked 'Amplitude Volts'; the control comprises a six-position range-selector-switch (a large knob with radial panel markings) and a variable control (a small knob with black panel markings).

With the variable control turned fully clockwise the amplitude of each 'main pulse' is indicated, for the no-load condition, by the switch-setting (volts). With any switch-setting, the pulse amplitude may be progressively reduced by anti-clockwise rotation of the variable control. The Minimum setting corresponds to approximately one-third of the range setting, e.g. with the switch set to 20 V and the variable control at 'Min', the no-load output amplitude is approximately 7 V.

With a load impedance equal to the output impedance of the selected range, the output amplitude should be half the no-load amplitude. This condition provides the best pulse shape with minimum overshoots.

Output impedance: 100 Ω ±5% on 20 V range;
50 Ω ±5% on the other ranges.

Chapter 3

Maintenance

3.1 CASE REMOVAL

CAUTION

Before removing the case of the instrument disconnect the mains cable from the supply. Should it be necessary to operate the unit with the case removed, e.g. during servicing or maintenance of the instrument, due care should be exercised to ensure that no physical contact is made with exposed connections, particularly mains connections in the vicinity of the supply-switch and mains transformer.

Both sections of the case may be removed when the two fixing screws, situated one at each side of the unit, have been withdrawn. Removal of the case should give sufficient access to the instrument for most fault finding and maintenance purposes. The instrument may, however, be partly dismantled to give greater access to certain components and sub-assemblies; should this be required refer to Sect. 3.5.

3.2 INDICATOR LAMP REPLACEMENT

The indicator lamp is accessible from the top of the instrument. Holding the rear of the lamp housing, gently withdraw the lamp assembly from its mounting grommet in the secondary front panel. Unscrew and replace the lamp; then insert the lamp assembly into the grommet.

Replacement lamp: 12 V 1 W tubular LES 679
Marconi Part No.: TF 2010/FPP/Z22749

If it becomes apparent that lamp failure is caused by a fault condition rather than prolonged use (e.g. as indicated by early failure of the replacement lamp) then the lamp circuit should be checked, (refer to Sect. 3.6.)

3.3 FUSE REPLACEMENT

Four cartridge fuses are incorporated in the instrument; they are mounted on the printed circuit power supply board type PCA 628/11, situated behind the front panel. All four fuses are held in clips attached to the component side of the board. The positions and ratings of the fuses are shown on diagram S63/51 (Fig. 1). Fuse FS3 is accessible from the top of the instrument; the remaining fuses are accessible from the bottom.

Replacement fuses are as follows:

Fuse	Rating	Marconi Part No. TF 2010/FPP/
FS1 (mains supply)	0.25 A Anti-surge	Z50291
FS2, 3, 4 (internal d.c. supplies)	0.5 A	Z19831

Should it become apparent that a fault condition has developed (e.g. as indicated by failure of the replacement fuse) the power supply circuit should be checked, (refer to Sect. 3.6).

3.4 CALIBRATION PROCEDURE

The calibration of the instrument is optimised during manufacture; therefore, in normal circumstances, the settings of the internal preset controls should not be altered.

If at some time (e.g. after prolonged service) it is found that the performance of the TF 2010 no longer conforms to the specification, re-alignment of the instrument may be carried out in accordance with the instructions given below.

If a distinct fault is known to exist, this should be located and rectified before adjustment is commenced (refer to Sect. 3.6).

For the purpose of calibration, the following equipment is required:

a) Resistor of value 100 Ω.
b) Double-beam oscilloscope possessing bandwidth of 50 MHz or greater; e.g. TF 2210.
c) Universal meter; e.g. Salford Selectest Super 50.
d) Frequency Meter capable of 2.5 MHz measurement.

In the following text reference is made to certain layout drawings on which lettered and numbered axes appear. The position of a component is indicated in the text by reference to two ordinates (e.g. 'B5'). The position of the component may be found, on the particular diagram, in the square formed by the intersection of the two ordinates.

3.4.1 Preliminary Connections and Settings

For case removal refer to Sect. 3.1.

(i) Check that the transformer-tapping is correctly position for the supply voltage (refer Sect. 2.1).

(ii) Connect a coaxial signal lead to the main-pulse output socket of the TF 2010 and terminate the coaxial lead in a 100 Ω resistor. Connect beam-1 of a wide-band double beam oscilloscope, so as to observe the waveform of the voltage across the resistor.

(iii) Connect beam-2 of the oscilloscope between the chassis-earth and switch SA wafer 1 stators 5 to 10 (see diagram S63/52 'Reference Point A).

(iv) Using a coaxial lead, connect the TF 2010 Pre-pulse output socket to the external trigger input socket of the oscilloscope. Set the oscilloscope to 'External Trigger Positive'.

(v) Connect a frequency meteer (capable of measuring to 2.5 MHz) between the chassis-earth and s switch SA wafer 1 stators 5 to 10 (see diagram S63/52 'Reference Point A).

(vi) Set the pre-pulse switch to ' + '.

(vii) Set the Amplitude switch (outer control) to ' 20 ' and set the main pulse polarity switch to ' + '.

(viii) Turn the preset controls, RV21 and RV22 (refer to diagram S63/50, locations C11 and D10 respectively), fully clockwise; then turn each control anti-clockwise through approximately 70°. Switch ON the TF 2010; the indicator lamp should light.

3.4.2 Power Supply

(a) Using a suitable voltmeter (e.g. Selectest set to the 25 V a.c. range) measure the potential between the tags of the lamp holder: the potential should not be greater than 11.5 V.

(b) Set the voltmeter to the 25 V d.c. range and connect as follows:
Meter ' - ' to pin 1 on printed circuit board PCA628/12.
(refer to diagram S63/53, Fig. 1).
Meter ' + ' to the chassis-earth.

(c) Adjust control RV2 (refer to diagram S63/51, Fig. 1, location D11) for a 10 V indication on the meter. Remove the meter.

(d) Connect the meter as follows:
Meter ' + ' to pin 2 on printed circuit board PCA628/12.
(refer to diagram S63/53, Fig. 1).
Meter ' - ' to the chassis-earth.

(e) Adjust control RV1 (refer to diagram S63/51, Fig. 1. location A8) for an 11.5 V indication on the meter. Remove the meter.

(f) Connect the meter as follows:
Meter ' + ' to switch SE wafer 1b stator 2 (see diagram S63/52, 'Reference Point B').
Meter ' - ' to the chassis-earth.

(g) Set the amplitude variable control (inner control) fully clockwise; then adjust control RV5 on amplitude printed circuit board PCA628/13 (see diagram S63/52) for 21.5 V indication on meter.

(h) Turn Amplitude variable control fully anti-clockwise: then adjust control RV4 on amplitude printed circuit board PCA628/13 (see diagram S63/52) for an 8 V indication on the meter.

(i) Repeat procedures (g) and (h) until the 21.5 V and 8 V indications are obtained for maximum and minimum settings of the amplitude variable-control. without further adjustment of RV5 and RV4 being necessary.
Remove the meter.

3.4.3 External Input Trigger Level

(i) Set the Frequency/Trigger selector to 'Ext. Input + '.

(ii) Connect the voltmeter (e.g. Selectest set to the 10 V d.c. range) between the centre-pin and the shell of the External Input socket. Adjust control RV10 (see diagram S63/50. location E4) for a meter indication of zero potential measured finally on meter range 2.5 V d.c.
Remove the meter.

3.4.4 Oscillator

(a) Switch the Frequency selector to '2.5 - 25 kHz range; adjust RV25 (see diagram S63/50. location A3) for a 3.5 to 4.5 V peak-to-peak unclipped sinusoidal output on oscilloscope beam -2.

(b) Set each of the following potentiometers to the mid-track position:

RV6	(see diagram S63/50. location C3)
RV7	(see diagram S63/50. location C3)
RV23	(see diagram S63/50. location C2)
RV24	(see diagram S63/50. location C1)

(c) Adjust the variable Frequency control for frequency meter indication of 2.5 kHz ±12 Hz. Note the amplitude of oscilloscope beam 2 waveform.

(d) The mark on the variable Frequency control-knob should coincide with the 2.5 black calibration mark. If necessary. slacken the grub screw (taking care that the frequency is not altered) and set the knob as required; lightly tighten the grub screw.

(e) Set the variable Frequency control knob to '25' and adjust RV6 and RV23 (see diagram S63/50. locations C3 and C2) for a frequency meter indication of 25 kHz ±125 Hz and the same amplitude as in (c) above.

(f) Repeat procedures (c) to (e) until the required frequencies are obtained at calibration marks '2.5' and '25' without further adjustments being necessary; firmly tighten the grub screw.

(g) Set the Frequency switch to the '250 kHz - 2.5 MHz' range and the variable control to '2.5'. Adjust the concentric capacitors C16 and C18 (see diagram S63/52) until a frequency meter indication of 250 kHz ±1.25 kHz is obtained with the same amplitude as in (c) above.

(h) Set the variable Frequency control to '25'; adjust RV7 and RV24 (see diagram S63/50, locations C3 and C1) until a frequency meter indication of 2.5 MHz ±12.5 kHz is obtained with the same amplitude as in (c) above.

(i) Repeat procedures (g) and (h) until the required frequencies are obtained at calibration marks '2.5' and '25' without further adjustments being necessary.

(j) Remove the leads of the frequency meter and the oscilloscope from the TF 2010.

3.4.5 Width and Delay Circuit

(i) Check that the knobs of the Delay and Width variable controls are secured so that the amount of off-scale movement preceding calibration mark '1' is equal to that following '10'.

(ii) Select the Single pulse mode and set the Frequency to 2.5 kHz.

(iii) Set the Delay and Width controls as follows:

Switch	:	'10 - 100 μs' range
Variable control	:	'10'

(iv) A pulse should be displayed by oscilloscope beam-1. Adjust RV20 (see diagram S63/50 location E8) for a pulse width of 100 μs ±3%.

(v) Set the Width variable control to '1'; adjust RV17 (see diagram S63/50, location F8) for a pulse width of 10 μs ±3% as displayed on the oscilloscope.

(vi) Repeat procedures (iv) and (v) until the required pulse widths are obtained, without adjustment, for '10' and '1' settings of the Width variable control.

(vii) Select the Double pulse mode.

(viii) With the Delay and Width controls set thus:

		Delay	Width
Switch	:	'10 - 100 μs' range	'10 - 100 μs' range
Variable control:	:	'10'	'1'

(x) check that two pulses, each of width 10 μs, are displayed by oscilloscope beam-1 and adjust RV15 (see diagram S63/50, location E6) for 100 μs ±3% duration between the leading edges of the pulses.

(ix) Set the Delay and Width controls as below:

Switch	:	'10 - 100 μs'	'1 - 10 μs' range
Variable control	:	'1'	'1'

(x) Adjust RV12 (see diagram S63/50 location F6) for 10 μs ±3% duration between the leading edges of the pulses.

(xi) Adjust RV18 (see diagram S63/50, location F8) until beam-1 pulses are each 1 μs ±3% wide.

(xii) Repeat procedures (viii) to (x) until the required inter-pulse durations are obtained, without further adjustment, for '10' and '1' settings of the Delay variable control.

(xiii) Set the Frequency controls to 25 kHz and the Delay and Width controls as below:

		Delay	Width
Switch	:	'10 - 100 μs' range	'0.1 - 1 μs' range
Variable control	:	'1'	'10'

Adjust C17 (see diagram S63/52) until the beam-1 pulses are 1 μs ±3% wide.

(xiv) Set the Width variable control to 1; adjust RV19 (see diagram S63/50, location E8) to give 0.1 μs ±3% wide pulses.

(xv) Repeat procedures (xiii) and (xiv) until the required pulse widths are obtained, without adjustment, for settings '1' and '10' of the Width variable control.

(xvi) Set the Delay and Width controls as below:

		Delay	Width
Switch	:	'1 - 10 μs' range	'0.1 - 1 μs' range
Variable control	:	'1'	'1'

Adjust RV13 (see diagram S63/50, location F5) for 1 μs ±3% duration between the leading edges of the pulses.

(xvii) Set the Delay switch to the '0.1 - 1 μs' range and the Delay variable control to '10'. Adjust C19 (see diagram S63/52) for 1 μs ±3% duration between the leading edges of the pulses.

(xviii) Turn the Delay variable control to '2'; adjust RV14 (see diagram S63/50, location E5) for 0.2 μs duration between the leading edges of the pulses.

(xix) Repeat (xvii) and (xviii) until the required inter-pulse durations are obtained, without adjustment, for settings '10' and '2' of the Delay variable control.

3.4.6 Output Pulse

(a) Set the Frequency control to 250 kHz, Delay to 0.5 μs, Width to 0.1 μs. Select the double-pulse mode and set the output amplitude to 20 V, polarity '+'.

(b) Observing beam-1 of the oscilloscope, adjust control RV21 (see diagram S63/50, location C11) for the fastest pulse rise-time obtainable without the fall-time (trailing-edge) exceeding 20 ns.

(c) Select negative output polarity. Observing beam-1, adjust control RV22 (see diagram S63/50, location D10) for the fastest pulse rise-time obtainable without the fall-time exceeding 20 ns.

(d) If procedures 'b' and/or 'c' produce a change in the 0.1 μs pulse width, readjust the pulse width controls in accordance with Sect. 3.4.5 procedures (x111) to (xv).

3.5 DISMANTLING PROCEDURE

For case removal refer to Sect. 3.1.

3.5.1 Power Supply Board (PCA 628/11)

Access to connections on the power supply board may be gained by removal of the rear panel. Unscrew (by anti-clockwise rotation) and remove the two cable stowage knobs from the projecting mounting-screws and free the panel from the mains cable grommet situated in a slot at one end. The panel may then be lifted away from the unit to expose the printed circuit power supply board.

To detach the power supply board, remove the screws marked 'A', 'B', 'C' and 'D' in diagram S63/51 Fig. 2; then, supporting the sub-assembly by holding the transformer, withdraw the screws marked 'E' in Fig. 2.

For complete detachment of the board it will be necessary to disconnect a number of leads which connect the sub-assembly to the main circuit of the instrument. Terminations should be noted carefully before the leads are disconnected.

The power supply board may be withdrawn via the top of the instrument.

3.5.2 Main Board (PCA 628/12)

Connections on the main printed circuit board are accessible from the base of the unit. This board is secured to the main frame by five screws inserted from the underside of the instrument. For general maintenance, removal of this board should not be necessary. It is recommended that the instrument be returned to an M.I. Service Dept. or Distributor if for any reason a major repair is required. (See Sect. 5.1.)

3.5.3 Amplitude Circuit Board (PCA 628/13)

This printed circuit board is secured to a bracket behind the front-panel-mounted Amplitude controls. The board is secured by two screws and is accessible from the top of the instrument.

If removal of the board is required, terminations should be noted before the leads are disconnected.

3.5.4 Attenuator Board (PCA 628/14)

The attenuator printed circuit board is mounted on the rear of the main-pulse output socket which is accessible from the base of the instrument. To detach the board, first note the terminations of the six leads which link it to the main circuit; then disconnect the leads, remove the nut of the main-pulse output socket and withdraw the board.

3.5.5 Frequency and Delay Boards (PCA 628/15)

Two printed circuit boards type PCA 628/15 are incorporated in the instrument. One is mounted on the switch assembly of the Frequency controls, the other on the switch assembly of the Delay controls. For switch removal refer to Sect. 3.5.7.

3.5.6 Slide Switches and Push-Button

To remove the push-button or either of the slide switches (i.e. the pre-pulse switch or mode-selector) it is necessary to first detach the front panel as follows:

a) Remove the inner control knobs.

b) Set each front panel knob to the extreme anti-clockwise calibration mark; then remove the main knobs. Withdraw the four chromium plated front panel fixing screws (situated one in each corner) and lift away the panel from the front of the instrument.

c) The nut of the push-button and the fixing screws of the slide switches will then be accessible from the front of the unit. Before the leads are disconnected from these components, their terminations should be noted.

d) When replacing the inner knob of a dual control it is essential that it is carefully repositione if the calibration accuracy of the instrument is to be maintained. Calibration checking is treated in Sect. 3.4.

3.5.7 Rotary Controls

To remove a rotary switch, first set its control knob/s to the extreme anti-clockwise calibration mark; then remove the knob/s.

Remove the fixing nut (around the bush of the switch) using a flat spanner inserted from the top of the instrument (or from the side, in the case of the main-pulse polarity and Frequency controls). Alternatively, a box spanner may be used to unscrew the fixing nut, but use of this tool should be avoided if possible since removal of all control knobs and detachment of the front panel will be necessary. (For detachment of the panel and removal of the control knobs refer to Sect. 3.5.6.)

Removal of the main-pulse-polarity and supply switch necessitates detachment of the supporting bracket which is secured by two screws to a vertical member at the right side of the unit.

Likewise, to withdraw the Frequency switch-assembly remove its bracket, and the power supply board, (refer to Sect. 3.5.1).

Before disconnecting the leads from a switch assembly, their termination points should be carefully noted.

Upon completion of any repair involving the replacement or alteration to the setting of a component, the calibration of the instrument should be checked in accordance with Sect. 3.4.

3.5.8 Handle Mechanism

The friction devices at the handle bearings are adjusted during instrument manufacture and henceforth should not be altered.

The handle and its mechanism constitute a removable sub-assembly which is secured at each side of the instrument by two round-head screws (inserted from within the unit).

Should the handle or its mechanism be damaged or become faulty, the sub-assembly may be detached and returned to an M.I. Service Dept. or Distributor for rectification.

To detach the sub-assembly screws remove the four round-head screws; then gently pull apart the side bars of the handle just sufficient to allow the assembly to be withdrawn from the frame of the instrument.

3.5.9 Front and Rear Panels

Front and rear panel removal is treated in Sections 3.5.6 and 3.5.1 respectively.

3.6 FAULT FINDING

3.6.1 General Information

The procedures prescribed for fault finding are not exhaustive but should cover most fault conditions encountered. Random adjustment of the internal preset controls should not be made in an attempt to clear a fault, otherwise conditions which complicate fault tracing may be introduced.

The calibration procedure presented in Sect. 3.4 may be carried out if a fault of a minor nature, symptomatic of mis-alignment, should develop. For other fault conditions select from Sect. 3.6 the sub-heading which corresponds to the nature of the fault and carry out the procedure given thereunder.

If a fault is present only on one range of a rotary switch, fault finding may be immediately localised to wafers of that particular switch, and furthermore, on each wafer, to components peculiar to the stator selected when the switch is set to the faulty range.

The fault finding procedure is arranged so that faults of a general nature may be quickly traced to a particular circuit-section.

The circuit of the instrument is shown by two diagrams which are provided at the rear of this manual. Diagram ES66/12 shows the main circuit arrangement and diagram ES66/11 shows the power supply circuits.

Functional descriptions of the various circuit-sections are given in Chapter 4 of this manual. Component values and location references are listed in Chapter 5.

For case removal, see Sect. 3.1.

Notes on Fault Correction

(a) Components should not be removed from the unit unless it is necessary to do so. When removing or inserting a component a heat sink (e.g. pliers) should be used to prevent damage to the component due to heat from the soldering iron.

(b) When removing or inserting components ensure that the supply is 'OFF'; otherwise high voltage surges may damage transistor-junctions.

(c) When heating connections on a printed-circuit board, the board should be in a horizontal plane to prevent solder from flowing across the printed circuit.

(d) After changing component/s check the calibration and operation of the instrument; if incorrect readjust, (see Sect. 3.4).

3.6.2 Fault Finding Procedures

The instruments recommended in Sect. 3.4 (voltmeter and oscilloscope) should be sufficient for general fault finding, but additional instruments may be necessary in certain cases, e.g. component testing.

Set the controls of the TF 2010 as follows:

Frequency	Delay	Width	Mode	Pre-Pulse	Amplitude
100 kHz	2 μs	0.5 μs	Double Pulse	+	+20 V

The main pulse output should be terminated in a 100 Ω resistor.

Select from below the sub heading which corresponds to the nature of the fault and carry out the procedure prescribed thereunder.

(1) Frequency Variable-control : Incorrect Function

Proceed in accordance with Sect. 3.6.3.

(2) Delay Variable-control : Incorrect Function

Proceed in accordance with Sect. 3.6.7.

(3) Width Variable-control : Incorrect Function

Proceed in accordance with Sect. 3.6.8.

(4) Amplitude Variable control : Incorrect Function

Proceed in accordance with Sect. 3.6.11.

(5) No Main-Pulse Output

Should no main output pulses be produced for + and - settings of the polarity switch on both Single and Double pulse modes, proceed as follows:

(a) Check that positive pre-pulses are produced at the Pre-Pulse output socket.
If pulses are present, pass to procedure (f) below.
If pulses are not present, continue with procedure (b).

(b) With the voltmeter, check the H.T. supplies:

Drg. S63/53, Fig. 1, Pin 1	:	-10 V
Drg. S63/53, Fig. 1, Pin 2	:	+11.5 V
Drg. S63/52, Reference point B:		+21.5 V

Should one or more of the above supplies be incorrect or absent, check in accordance with Sect. 3.6.11, then proceed with (c) below.

(c) With correct H.T. supplies, check the oscillator (and make adjustments if necessary) in accordance with Sect. 3.6.3.

(d) With correct oscillator conditions, check the waveform at VT15 collector (WF11), (see Sect. 3.6.4); if correct, check the circuits of VT17 and VT18 (see Sect. 3.6.5).

(e) If the waveform at VT15 collector is incorrect, check the circuits of VT13, VT14 and VT15 (see Sect. 3.6.4). If no fault is found proceed with (f) below.

(f) Check waveform WF30, see Sect. 3.6.8.
If incorrect: Check VT25 circuit (Sect. 3.6.7) and the circuits of MR32 and VT26 (Sect. 3.6.8).

If correct: Check VT27 collector (Sect. 3.6.8) and if incorrect check the Width circuit (Sect. 3.6.8). If VT27 collector is correct, check VT28 circuit and switch SE2a (Sect. 3.6.9).
If VT28 circuit is correct, check the output stage as in Sect. 3.6.10.

(6) No 2nd Main-Pulse on the Double Pulse Mode

Check VT20 circuit, MR25 and switch, SF (see Sect. 3.6.5).

(7) Mains Pulses Absent on the Single Pulse Mode

If main pulses are produced on the Double pulse mode but are absent on the Single pulse mode, proceed as below:

(a) Check VT23 collector circuit (Sect. 3.6.7). If correct, check the circuits of VT24 and VT25 and MR31 (Sect. 3.6.7).

(b) If the circuits of VT24, VT25 and MR31 are correct, then check the circuit of VT21, (Sect. 3.6.5). If this is correct, check the Delay circuit, (Sect. 3.6.7).

(8) Mains Pulses Obtainable in Positive Polarity Only

(a) Set the main pulse polarity switch to ' - '.

(b) Check the H.T. potential (with respect to chassis-earth) at the junction of R102 and C66; it should be -21.5 V.

If the H.T. is incorrect: Check switch SE1b and SE1c and the power supply as in Sect. 3.6.11.

If the H. T. is correct: Check that waveform WF37 (refer to Sect. 3.6.9) is present at switch SE2a stator (see diagram S63/52). If the waveform is absent or incorrect, check switch SE2a. If the waveform is correct, check that waveform WF45 is present at VT33 collector (see Sect. 3.6.10) and that similar signals are present at board PCA628/13 (see diagram S63/52) pins 4 and 3.

(9) Main-Pulses Obtainable in Negative Polarity Only

(a) Set the main pulse polarity switch to ' + '.

(b) Check the H. T. potential at the junction of R95 and C63 with respect to chassis-earth; it should be +21.5 V.

If the H. T. is incorrect: Check switch SE1b and SE1c (diagram S63/52) and the power supply as in Sect. 3.6.11.

If the H. T. is correct: Check that waveform WF37 (refer to Sect. 3.6.9) is present at switch SE2b stator 2 (see diagram S62/52). If it is not present, check the switches SE2a and SE2b, and VT29 circuit, (see Sect. 3.6.9).
If waveform WF37 is present at SE2b stator 2, check that waveform WF41 (refer to Sect. 3.6.10) is present at VT31 collector and at board PCA628/13 (see diagram S63/52) pins 4 and 3.

(10) Pre-Pulse Obtainable in Positive Polarity Only

Check switch S9 and VT19 circuit as in Sect. 3.6.5.

(11) Instrument Not Responsive to Positive External Signals or Push-button Operation (Triggered by Negative External Signals)

Check VT16 circuit (Sect. 3.6.6) and the trigger circuit (Sect. 3.6.4).

(12) Instrument Not Responsive to External Input Signals of Either Polarity

Check the trigger circuits as in Sect. 3.6.4.

(13) Instrument not responsive to High Frequency External Input Signals

Check C38 (for an open-circuit lead etc.), if correct see Sect. 3.6.4.

(14) Power Supplies Faulty

Check as in Sect. 3.6.11.

3.6.3 Oscillator

Check the oscillator output as developed across R39. This should be sinusoidal and of amplitude 3.5 to 4.5 V peak-to-peak, (see waveform diagram WF1).

Fault symptoms		Procedure
(a) Excessive Amplitude	:	Check thermistor TH2 for a possible open circuit.
(b) Low Amplitude	:	Check thermistor TH1 for a possible open circuit.
(c) No Oscillation (all ranges)	:	(i) Check the H. T. supplies (see Sect. 3.6.11). (ii) Check thermistor TH1 for a possible open circuit. (iii) Observe the waveforms at VT10, 11 and 12 (see waveforms WF2-5).

Fault symptoms		Procedure
		(iv) Check the connections of the leads from switch SA (diagram S63/52) to the main board.
		(v) Check potentiometers RV8 and RV9 (drawing S63/52) and associated leads.
(d) Unstable operation	:	Follow the alignment procedure (Sect. 3.4) and ensure that the oscillator output, developed across R39, is 3.5 to 4.5 V peak-to-peak.
(e) Incorrect functioning of the variable Frequency control	:	Check potentiometers RV8 and RV9 (drawing S63/52) and the associated leads.

3.6.4 Trigger Circuit

(a) Set the Frequency switch to 'Ext. Input + ': set the mode selector to 'Single'.

(b) Check the following d.c. conditions and refer to the right-hand column should a fault condition be found.

Voltage values are with respect to chassis-earth.

Check	Procedure for Fault Finding
(i) Centre-pin of the Ext. Input socket: 0 V.	Check the setting of RV10 (refer to Sect. 3.4.3). Check VT13, MR15. MR16. R42 and R43. Inspect switch SA1 (drawing S63/52) for faulty operation.
(ii) VT13 emitter: -0.7 V ±0.1 V.	Check R45 and VT13.
(iii) VT14 collector: +9.5 V ±0.5 V.	If the voltage is low, inspect SA2 (drawing S63/52) for an open-circuit, check R46 and test VT14 for leakage.
(iv) VT15 collector: approximately +1.5 V (and VT14 emitter).	If the collector voltage is high: check R49, R50 and VT15.
Check the following d.c. conditions while holding the Manual push-button depressed.	
(v) VT14 collector: approximately +1 V. VT15 collector: +11.5 V. VT14 emitter: approximately +1 V.	No change in d.c. levels when push-button is pressed. Check that VT13 emitter potential swings positive when the push-button is depressed: for no positive swing, check the push-button circuit. If VT14 collector voltage does not fall to approximately +1 V when the push-button is depressed, check VT14 emitter voltage (approximately +1 V) and check transistor VT14. If VT14 collector level changes correctly but VT15 collector level does not change correctly, check R51 and check VT14 for leakage. Check also C39 for leakage or short-circuit.

(vi) Release the push-button. Change the Frequency switch setting from 'Ext. Input +' to 'Ext Input -'.
The d.c. conditions of (iii) and (iv) above, should change to the values shown in (v).

If there is no change in the d.c. conditions, then check MR18 and MR19 and the operation of the switch SA2 (drawing S63/52).

(c) Set the frequency to 100 kHz. Check the waveforms as shown (i.e. waveforms WF6 to WF11).

If the duration of the negative-going edge of VT15 output is slow compared with waveform WF11, check C38 for a possible open-circuit connection.

3.6.5 Shapers, Emitter Follower and Pre-Pulse Output

(a) Set the Frequency switch to 'Ext Input -'.

(b) Check the following d.c. conditions and refer to the right hand column should a fault condition be found. Voltage values are with respect to chassis-earth.

	Check	Procedure for Fault Finding
(i)	VT17 collector: not greater than +0.5 V.	If the voltage is greater than +0.5 V, check R55, MR21, MR22 and VT17.
(ii)	VT18 emitter: not greater than +0.5 V.	If the voltage is greater than 0.5 V, check VT18.
(iii)	Centre-pin of the Pre-Pulse socket: 0 V VT19 collector: +11.5 V VT20 collector: +11.5 V VT21 collector: +11.5 V	If the collector voltages are low, check VT19, VT20 and VT21 for leakage.

(c) Set the Frequency to 100 kHz. Check the waveforms as shown (i.e. waveforms WF12 to WF20

If the pulse at VT17 is too wide compared with waveforms WF12 and 13, check R55, MR21, MR22 and C40. If the pulses at VT19, VT20 and VT21 are too narrow or too wide compared with waveforms WF15-20, check the components in the base circuits of the transistors.

3.6.6 Inverter

(a) Set the Frequency switch to 'Ext Input +'.

(b) Check the following d.c. conditions and refer to the right hand column should a fault condition be found. Voltage values are with respect to chassis-earth.

	Check	Procedure for Fault Finding
(i)	VT16 collector +11.5.	If the collector voltage is low, check VT16 for leakage.

(c) Apply 100 kHz signals to the Ext Input socket (see Sect. 2.6) and check the waveforms (i.e. waveforms WF21 and WF22).

If the pulses are too wide or too narrow compared with waveforms WF21 and 22, check the base circuit components of VT16.

3.6.7 Delay Circuit and Shapers

(a) Set the Frequency switch to 'Ext Input -'.

(b) Check the following d.c. conditions and refer to the right hand column should a fault condition be found. Voltage values are with respect to chassis-earth.

Check	Procedure for Fault Finding
(i) VT22 collector: +11.5 V.	If the collector voltage is low, check VT22 for leakage and carry out check (ii).
(ii) VT23 collector not greater than +0.5 V.	If the collector voltage is high, check VT23, (the gain should be greater than 60) and check RV11, 14, 15 and R70.
(iii) VT24 collector not greater than +0.5 V.	If VT24 collector voltage is high; check R72, MR28, MR29 and VT24.
(iv) VT25 collector: +11.5 V.	If the collector voltage is low; check VT25 for leakage.

(c) Set the Frequency control to 100 kHz and check the waveforms as shown (i.e. waveforms WF23 to WF29).

(1) If the operation of the Delay Variable control is restricted, check VT23 for leakage; check RV11.

(2) If the rise-time of WF25 is too slow; check C45.

(3) If the output pulses of VT24 or VT25 are too wide or too narrow compared with waveforms WF27 and WF29; check the base circuit components of the associated transistor.

3.6.8 Width Circuit and OR-Gate

(a) Set the Frequency switch to 'Ext Input -'.

(b) Check the following d.c. conditions and refer to the right hand column should a fault condition be found. Voltage values are with respect to chassis-earth.

Check	Procedure for Fault Finding
(i) VT26 collector: +11.5 V.	If the collector voltage is low, check VT26 for leakage and carry out check (ii).
(ii) VT27 collector not greater than+0.5 V.	Collector voltage high; check VT27 (the gain should be greater than 60), and check RV16, 19, 20 and R81.

(c) Set the Frequency control to 100 kHz and check the waveforms as shown (i.e. waveforms WF30 to WF33).

(1) If the operation of the Width variable control is restricted; check VT27 for leakage; check RV16.
(2) If the rise-time of WF33 is too slow;check C53.

3.6.9 Output Shapers and Inverter

(a) Set the Frequency switch to 'Ext Input + '.

(b) Check the following d.c. conditions and refer to the right hand column should a fault condition be found. Voltage values are with respect to chassis-earth.

Check	Procedure for Fault Finding
(i) VT28 collector approximately +10 V. (Main pulse polarity switch set to +).	If the collector voltage is low; check C61, check VT27 collector voltage (see Sect. 3.6.8) and check VT28 for leakage.
(ii) VT29 collector not greater than +0.5 V. (Main pulse polarity switch set to +).	If the collector voltage is high; check the switch connections, SE2a, stator 2 (refer dgm. S63/52); check R86 and VT29.

(c) Set the Frequency control to 100 kHz and check the waveforms as shown (i.e. waveforms WF34 to WF37).

(1) If the rise time of VT28 output (WF35) is too slow; check C59.

(2) If the rise time of VT29 output (WF37) is too slow; check C61.

(3) If there is no output pulse from VT28 or VT29; check transistors VT28 and VT29.

3.6.10 Output Stages

(a) Set the Frequency switch to 'Ext Input + '.

(b) Check the following d.c. conditions and refer to the right hand column should a fault condition be found. Voltage values with respect to chassis-earth.

Check	Procedure for Fault Finding
(i) VT30 collector; approximately +2 V.	If the collector voltage is low; check VT30 for leakage.
(ii) VT30 emitter: -10 V.	
(iii) VT31 collector between +1 V and +2 V.	If the collector voltage is high; check RV21 and R92.
VT32 collector approximately -2 V.	If the collector voltage is low; check VT32 for leakage.
VT32 emitter; +11.5 V.	
VT33 collector: between -1 V and -2 V.	If the collector voltage is high; check RV22 and R99.

(c) Set the Frequency control to 100 kHz and check the waveforms as shown (i.e. waveforms WF38 to WF45).

(1) If VT30 is permanently turned on; check MR3

(2) If VT30 output cut-off is late; check MR35.

(3) If VT31 output rise-time is too slow; check the setting of RV21 (see Sect. 3.4.6); check MR3 VT31 and the associated components.

(4) If VT32 output pulse cut-off is late; check MR37.

(5) If VT33 output rise time is too slow; check RV22 setting (see Sect. 3.4.6), MR39, VT33 and the associated components.

3.6.11 Power Supplies

Instructions for setting the voltages of the three h.t. supplies (circuit diagram ES66/11) are given in Sect. 3.4.2.

Should a fault condition be encountered, the following tests may be conducted.

Check	Procedure for Fault Finding
(i) No output from the three supply circuits.	If the indicator lamp is not illuminated, check the mains fuse FS1 (see Sect. 3.3) and check that the mains input is present at the transformer (T1) primary. If necessary, check the lead connections (Sect. 2.1), switch SE (see diagram S63/52) and the outputs of T1 secondary windings. Check the transformer voltage setting (Sect. 2.1) then fuses FS2, FS3 and FS4 (Sect. 3.3).
(ii) No output from one or two supplies.	Check the associated fuse FS2, FS3 or FS4 (Sect. 3.3). Check the output of the associated bridge-rectifier circuit, the negative terminal being the junction of the capacitor and the fuse. Across C1 : approximately 28 V d.c. " C6 : " 17 V d.c. " C11 : " 17 V d.c. If the voltage is incorrect, check the corresponding rectifier and capacitor. If the components are in order, check the circuit voltages as below.

Voltages within Stabilizer Circuits

Voltage values are with respect to chassis-earth except where stated otherwise.

Circuit fed via: MR1 (21.5 V H.T. Supply)	MR5 (11.5 V H.T. Supply)	MR9 (10 V H.T. Supply)
		All readings with respect to Pin 2 of PCA 628/12 board.
VT1 collector approximately +28 V	VT4 collector approximately +17 V	VT7 collector approximately +17 V
VT1 emitter: +8 to +21.5 V (set by RV3, 4 and 5)	VT4 emitter: +11.5 V (set by RV1)	VT7 emitter: +10 V (set by RV2)
VT1 base: +8.7 to +22.2 V	VT4 base approximately +21.1 V	VT7 base approximately +10.6 V
VT2 base and emitter: +9.4 to +22.9 V	VT5 base and emitter: approximately +12.8 V	VT8 base and emitter: approximately +11.3 V
VT3 collector: +9.4 to +22.9 V	VT6 collector: +12.8 V	VT9 collector: +11.3 V
MR2/R5 junction +5.6 V ±5%	MR6/R10 junction +5.6 V ±5%	MR10/R17 junction +5.6 V ±5%

Should the voltage values not conform to the above table, check the components of the associated circuit.

Chapter 4

Circuit description

4.1 POWER SUPPLIES (Diagram ES66/11)

Diagram ES66/11, provided at the rear of this manual, shows the mains input circuit and the three direct current power supplies employed within the instrument.

Both 'live' and 'neutral' lines of the mains input (Red-core: live, Black-core: neutral, Green-core: chassis-earth) are switched by SE3 (a and b) and a 250 mA anti-surge fuse FS1 is incorporated in the 'live' supply line to transformer T1.

Three h.t. supplies are derived from separate secondary windings of T1 via bridge-rectifiers (MR1, 5 and 9) and conventional stabilizer circuits in which the reverse breakdown voltage of a silicon Zener diode (MR2, 6 and 10) is employed as a reference.

In each stabilizer circuit a potentiometer is incorporated as an output voltage control (RV1, 2 and 3) and a 500 mA fuse (FS2, 3 and 4) is connected in the positive return line.

The three circuits are arranged to provide the following supplies:

Circuit Incorporating Rectifier	Output Pins of Board PCA628/11		Stabilized Output
MR1	Pin 3 (+) Pin 5 (-)		21.5 V
MR5	Pin 6 (+) Pin 7 (-)	connected to chassis-earth	11.5 V
MR9	Pin 1 (+) Pin 2 (-)		10 V

The 21.5 V positive line is connected to chassis-earth when the main pulse polarity switch is set to ' - '; the negative line is connected to chassis-earth when the switch is set to '+'.

For the 21.5 V supply circuit, the Amplitude variable control RV3 (connected to the Amplitude Board PCA628/13) functions as an output voltage control, whilst preset potentiometers RV4 and 5 with resistors R20 and 21 govern the voltage range over which RV3 is functional.

Indicator lamp ILP1 is connected in series with resistor R27 (75 Ω) between pins 10 and 11 of the power supply board. The lamp is powered by a 16 V a.c. output of T1 (i.e. that used to supply rectifier MR9.

4.2 MAIN CIRCUIT (Diagram ES66/12)

The main circuit of the instrument is shown on diagram ES66/12 provided at the rear of this manual. A block schematic diagram of the circuit is also provided (diagram S63/54). For the purpose of description the circuit will be treated in distinct sections as follows.

4.2.1 Oscillator

The circuit incorporating transistors VT10 to VT12 is that of a variable frequency Wien-bridge oscillator which serves as an internal frequency source.

Components selected at switch-wafers SA4-6 (a and b) when the Frequency switch SA is set to positions 5 to 10, together with the setting of the Frequency variable control (ganged potentiometers RV8 and 9) determine the frequency of oscillation. The circuit, which employs complementary amplifiers VT10-VT11, is gain/temperature controlled by thermistors TH1 and TH2 connected in the feedback loop from output emitter follower VT12.

Sinusoidal oscillator-output signals at the selected frequency and of amplitude approximately 4 V peak-to-peak are fed to the Trigger Circuit via the rotor of switch SA1 when the Frequency switch is set to positions 5 to 10.

4.2.2 Trigger Circuit and Inverter

This circuit employs emitter follower VT13 and Schmitt trigger stage VT14-15. It is operated by signals selected by the rotor of Frequency switch wafer SA1.

On switch position 1, a positive trigger signal occurs at VT13 base when, upon depression of the Manual push-button SH, C35 discharges.

Signals applied to the 'Ext Input' socket SKTA operate the circuit when switch SA1 is set to position 2 (-) or position 3 (+). On switch positions 5 to 10 the circuit is triggered by signals from the oscillator, switch position 4 is unused.

Diodes MR15 and 16 serve as input signal limiters for the emitter follower VT13 which is connected between the -10 V and the +11.5 V supply lines. The base is normally held at approximately chassis-earth level by the potential divider chain R42, 43 and RV10, whilst the emitter is normally held at approximately -0.7 V with respect to chassis-earth.

The setting of switch SA2 (a wafer of the Frequency/Trigger selector) determines the trigger polarity, which is 'positive' on positions 1 and 3 but 'negative' on the remaining positions.

'Negative' settings

For positions 2 and 5-10 of switch SA2, VT14 is normally conductive whilst VT15 is cut-off. Upon receipt of a negative-going signal at VT13 base, diodes MR18 and 19 conduct to operate the trigger circuit; VT14 is cut-off and VT15 is turned on.

The negative-going signal produced at VT15 collector is selected (as the input for the following Shaper circuit) by the rotor of switch SA3.

'Positive' settings

On positions 1 and 3 of switch SA2, diodes MR18 and 19 are by-passed by a short circuit link. Transistor VT14 is normally held non-conductive by the base biasing circuit R47 (connected to the +11.5 V line) and R46 (connected to VT13 emitter, the potential being approximately -0.7 V, therefore VT15 is held conductive. Upon receipt of a positive-going signal, the potential at VT14 base swings positive turning on VT14 which in turn cuts off VT15. The resultant positive-going signal produced at VT15 collector is inverted by VT16 and is selected (as an output for the following Shaper circuit) by the rotor of switch SA3.

4.2.3 Trigger-Pulse Shaper and Emitter Follower (VT17, VT18): Pre-Pulse Output

Transistor VT17 functions as a pulse shaper for signals received from the trigger circuit via the rotor of switch SA3 and capacitor C40: the transistor is normally bottomed due to the base biasing circuit - R55, MR21 and 22.

Upon receipt of a negative-going signal at SA3 rotor, VT17 is cut-off for a period of approximately 200 ns due to the differentiating action of C40 and base biasing resistor R55. The resultant positive-going pulse produced at VT17 collector is applied to emitter follower VT18.

From the emitter of VT18 the signal is passed via one of the following circuits, viz:

i) Via the pre-pulse polarity switch SG stator 1 and C69 to the pre-pulse output socket SKTB. This signal constitutes the positive-going pre-pulse.

ii) Via inverter VT19 and the pre-pulse polarity switch SG stator 2 and C69 to socket SKTB. The inverted signal then constitutes the negative-going pre-pulse.

The positive pulse produced at VT18 emitter is also used to trigger both the delay and width circuits which are treated in Sections 4.2.4 and 4.2.5 of this manual.

4.2.4 Trigger-Pulse Inverter VT21; Delay Circuit and Shapers VT24 and 25

The positive trigger pulse produced at VT18 emitter (see Sect. 4.2.3) is subjected to the differentiating action of C44-R64: the resultant signal is inverted by VT21 so that a negative pulse of width approximately 100 ns occurs at the collector. The leading edge of the pulse triggers the delay monostable circuit formed by VT22 and VT23 via diode MR27.

When the monostable is triggered, VT22 (normally non-conductive) is turned on whilst VT23 is cut-off. The circuit remains in the triggered condition for a duration (the Delay period) determined by the setting of the Delay switch SB (1 and 2) and the Delay variable control, RV11. The Delay period is dependent upon the time constant of the CR-circuit formed by the VT22-collector to VT23-base coupling capacitor (selected at switch wafer SB2a) and the resistance between VT23-base and the +11.5 V supply line; the value of resistance depends upon the preset potentiometer selected at switch wafer SB2b.

At the end of the Delay period the monostable reverts to the stable condition (i.e. VT22 cut-off; VT23 conductive). The negative-going trailing edge of the resultant pulse at VT23 collector operates the pulse shaper circuit VT24-VT25 which serves to produce a negative pulse of width approximately 100 ns at VT25 collector. The latter signal is applied to OR-gate consisting of R76, MR31 and 25 as treated in Sect. 4.2.5.

4.2.5 Trigger-Pulse Inverter VT20; OR-gate and Width Circuit

The positive trigger pulse produced at VT18 emitter (see Sect. 4.2.3) is subjected to the differentiating action of C43-R62. The resultant signal is inverted by VT20 and is applied to the OR-gate formed by R76, MR31 and 25 when the Mode selector switch SF is set to position 1 (Double

The width circuit is identical to the delay circuit. Transistors VT26-27 form the monostable whilst the duration for which the circuit remains in the triggered condition (this duration constitutes the 'width' of each main output pulse) is determined by the setting of the Width switch 'SC' and the Width variable control, RV16.

In the Single pulse mode (SF set to position 2) the monostable formed by VT26-27 is triggered by the negative-going edge of the pulse initiated by the delay circuit, produced at VT25 collector and applied via diodes MR31 and 32.

In the Double pulse mode (SF set to position 1) the monostable is triggered twice; firstly by the negative-going edge of the trigger pulse inverter (VT20) output pulse, applied via diodes MR25 and 32, and secondly, at the end of the delay period, by the negative-going edge of the pulse produced at VT25 collector and applied via diodes MR31 and 32. It is required that the Width setting by less than the Delay setting in order that monostable VT26-27 shall have reverted to the stable state before the second trigger pulse occurs. The double triggering of the monostable occur between each consecutive pre-pulse. Pulses produced at VT27 collector are applied to the pulse shaper VT28.

4.2.6 Pulse Shaper VT28 and Output Circuits

The circuit of VT28 operates as a pulse shaper for output signals received from the width circuit (i.e. from VT27 collector). Negative pulses approximately rectangular in shape and possessing rise and fall times of the order of 20 ns (the pulse width being determined by Width control settings), are produced at VT28 collector. These signals are passed via one of two output circuits, selection depending upon the setting of the output polarity switch SE.

The output circuit selected for negative polarity (SE2a position 3) is formed by transistors VT32 and 33 and is effectively the complement of the other output circuit selected for positive polarity (SE2a and SE2b position 2) and incorporating transistors VT30 and 31, for which VT29 serves as an input inverter.

The 21.5 V h.t. supply is used to power the final stage of each output circuit (VT31; VT33). The supply is applied to the circuits by means of switch wafers SE1b and SE1c; the positive line of the supply is connected to chassis-earth when the circuit of VT33 is selected for negative output polarity, whilst the negative line is connected to chassis-earth when the circuit of VT31 is selected.

Potentiometer RV3 shown on diagram ES66/11, i.e. the voltage control potentiometer of the 21.5 V supply, serves as the Amplitude variable control. The Amplitude switch or attenuator is treated in Sect. 4.2.7.

Since both output circuits function in a similar manner, only the operation of the circuit for a negative pulse output will be described.

Normally VT32 is held cut-off whilst VT33 conducts due to the base to -10 V supply line connection formed by R100, RV22 and R99. Upon receipt of a negative pulse at VT32 base, the collector potential tends to that of the +11.5 V supply line and hence VT33 is cut-off by reverse emitter to base bias, the value of which is limited by R98, 100 and 101. To achieve fast switching action, saturation of VT32 and VT33 is avoided by the use of diodes MR37 and MR39 respectively. The action of the series-connected diodes MR11, 14 (SE1a position 3) prevents the collector to emitter potential of VT33 (which remains due to non-saturation), from being applied to the following circuit (i.e. the attenuator). Therefore the centre-pin of output socket SKTC is normally held at chassis-earth potential.

4.2.7 Attenuator

Signals from the selected output circuit (VT30 and 31 or VT32 and 33) are applied to the attenuator by means of switch wafer SD1a (i.e. a wafer of Amplitude switch SD). The attenuator circuit comprises the printed circuit Attenuator Board PCA628/14 (components R22-26) and resistors R103-106. The attenuator network is tapped by the rotor of switch wafer SD1b and connected to the output socket, SKTC. Amplitude-switch positions 1 to 5 correspond to the 0.5, 1, 2, 5 and 10 V ranges respectively, whilst on switch position 6 the signals from the output circuit are fed directly to SKTC; the latter setting corresponds to the 20 V range.

The attenuator is designed to provide an output impedance of 50 Ω on the first five ranges and 100 Ω on the sixth (20 V) range.

Chapter 5

Replaceable parts

5.1 ORDERING INFORMATION

When ordering spare parts quote the M.I. FPP Part No., plus the instrument type number, e.g. TF 2010/FPP/X12345/67.

Orders may be placed via a Marconi Instruments Distributor or direct to:

Marconi Instruments Ltd.,
Service Division,
The Airport,
Luton, Bedfordshire, LU2 9NS,
England.

Spares supplied against Marconi Part Numbers are electrically interchangeable with those originally fitted, but may not always be identical.

5.2 POWER SUPPLY (Drg. ES66/11; S63/51, Fig. 1)

Capacitors	Value	Description	Location on Diagram	Marconi Part No. TF 2010/FPP/
C1	1000 µF 50 V	Plessey	C6	Y20643/31
C2	100 µF 25 V	Plessey	B8	Y20643/34
C3	0.1 µF	T.C.C.	B10	26582-208
C4	100 µF 25 V	Plessey	C9	Y20643/34
C5	500 µF 25 V	Plessey	D9	26427-319
C6	2000 µF 25 V	Plessey	B5	Y20643/32
C7	100 µF 25 V	Plessey	A4	Y20643/34
C8	100 µF 25 V	Plessey	C4	Y20643/34
C9	100 µF 25 V	Plessey	D7	Y20643/34
C10	500 µF 25 V	Plessey	C7	26427-319
C11	1000 µF 25 V	Plessey	D5	Y20643/33
C12	100 µF 25 V	Plessey	B10	Y20643/34
C13	100 µF 25 V	Plessey	C10	Y20643/34
C14	100 µF 25 V	Plessey	C10	Y20643/34
C15	500 µF 25 V	Plessey	D10	26427-319
C100	0.1 µF ±10%	Mullard		Z21135/8
C101	0.1 µF ±10%	Mullard		Z21135/8

Diodes	Type	Description	Location on Diagram	Marconi Part No.
MR1	1B 15 PO5	Texas	C3	Z20648/11
MR2	BZY88/C5/V6	Mullard	C8	X20639/30
MR3	10AS	Plessey	B4	X20639/13
MR44	10AS	Plessey	A4	X20639/13
MR5	1B 15 PO5	Texas	A3	Z20648/11
MR6	BZY88/C5/V6	Mullard	C6	X20639/30
MR7	10AS	Plessey	C4	X20639/13
MR8	10AS	Plessey	D4	X20639/13
MR9	1B 15 PO5	Texas	D3	Z20648/11
MR10	BZY88/C5/V6	Mullard	C11	X20639/30

Fuses	Rating	Description	Location on Diagram	Marconi Part No.
FS1	250 mA	Anti-surge	D1	Z50291
FS2	500 mA	L 562, size 00	D6	Z19831
FS3	500 mA	L 562, size 00	A5	Z19831
FS4	500 mA	L 562, size 00	D8	Z19831

Indicator Lamp

ILP1	12 V	1 W	Z22749

Resistors	Value		Description	Location on Diagram	Marconi Part No. TF 2010 FPP/
R1	3 Ω ±10%	3 W	Welwyn AW3101	B10	Z21092/3
R2	1 kΩ "	½ W		B9	24232-080
R3	1 kΩ "	½ W		B8	24232-080
R4	2.2 kΩ "	½ W		B9	24232-088
R5	1.8 kΩ "	½ W		B8	24232-086
R6	1.5 Ω "	3 W	Welwyn AW3101	B7	Z21092/14
R7	1 kΩ "	½ W		B7	24232-080
R8	1 kΩ "	½ W		B7	24232-080
R9	1 kΩ "	½ W		B7	24232-080
R10	1 kΩ "	½ W		C7	24232-080
R11	330 Ω "	½ W		B8	24232-063
R12	1 kΩ "	½ W		B8	24232-080
R13	1.5 kΩ "	3 W	Welwyn AW3101	B11	Z21092/14
R14	1 kΩ "	½ W		B11	24232-080
R15	1 kΩ "	½ W		B11	24232-080
R16	1 kΩ "	½ W		B11	24232-080
R17	1 kΩ "	½ W		C11	24232-080
R18	330 Ω "	½ W		C11	24232-063
R19	1 kΩ "	½ W		C11	24232-080
R20	100 Ω "	½ W		Amp. Board	24232-050
R21	100 Ω "	½ W		" "	24232-050
R27	75 Ω "	3 W	Welwyn AW3101	" "	Z21092/15

Resistors Variable

RV1	1 kΩ	½ W	A8	25611-114
RV2	1 kΩ	½ W	D11	25611-114
RV3	1 kΩ	½ W	Switch SD	X20999/43
RV4	1 kΩ	½ W	Amp. Board	25611-114
RV5	1 kΩ	½ W	" "	25611-114

Transistors

VT1	40250	R. C. A.	A9	X20638/60
VT2	BSX21	Mullard	A9	X20638/64
VT3	BSX21	Mullard	C9	X20638/64
VT4	40250	R. C. A.	A6	X20638/60
VT5	2N2369	Texas	A6	28452-197
VT6	2N2369	Texas	C7	28452-197
VT7	40250	R. C. A.	A11	X20638/60
VT8	2N2369	Texas	A11	28452-197
VT9	2N2369	Texas	C11	28452-197

Transformer	Type	Description	Location on Diagram	Marconi Part No. TF 2010/FPP
T1	Mains		B2	Y50236

5.3 MAIN BOARD (Drg. ES66/12; S63/50 and 52)

Capacitors Variable	Value	Description		
C16	4-60 pF	Mullard	Switch SA	Z21135/8
C17	4-60 pF	Mullard	Switch SB	Z21135/8
C18	4-60 pF	Mullard	Switch SA	Z21135/8
C19	4-60 pF	Mullard	Switch SB	Z21135/8

Capacitors				
C20	620 pF ±2%	Suflex HS10/F	Switch SA	Y20641/30
C21	6800 pF ±2%	Lemco 3220	Switch SA	Y20644/8
C22	0.068 µF ±2%	Wima Tropyfol 'M'	Switch SA	26511-343
C23	0.68 µF ±2%	Wima Tropyfol 'M'	Switch SA	26511-379
C24	6.8 µF ±5%	Plessey Type S	Switch SA	Y22776/9
C25	6.8 µF ±5%	Plessey Type S	Switch SA	Y22776/9
C26	0.68 µF ±2%	Wima Trolyfol 'M'	Switch SA	26511-379
C27	0.068 µF ±2%	Wima Trolyfol 'M'	Switch SA	26511-343
C28	6800 pF ±2%	Lemco 3220	Switch SA	Y20644/8
C29	620 pF ±2%	Suflex HS10/F	Switch SA	Y20641/30
C30	47 pF ±10%	L. E. M.	Switch SA	Y20641/15
C31	2000 µF 12 V	Plessey	C5	Y20643/27
C32	0.1 µF	T. C. C.	A4	26582-208
C33	100 µF 25 V	Plessey	C4	Y20643/34
C34	33 pF	L. E. M.	E1	Y20641/14
C35	6.8 µF 15 V	Mullard	D1	J22776/9
C36	0.1 µF	T. C. C.	Fig. 2	26582-208
C37	47 pF ±10%	L. E. M.	E3	Y20641/15
C38	80 pF	L. E. M.	D3	Y20641/10
C39	47 pF	L. E. M.	E2	Y20641/15
C40	47 pF	L. E. M.	B6	Y20641/15
C41	47 pF	L. E. M.	C6	Y20641/15
C42	0.1 µF	T. C. C.	B6	26582-208
C43	80 pF	L. E. M.	B7	Y20641/10
C44	47 pF	L. E. M.	B7	Y20641/15
C45	60 pF	L. E. M.	E5	Y20641/9
C46	1 µF ±2%	Wima 'M'	Switch SB	26511-381
C47	0.1 µF ±2%	Wima 'M'	Switch SB	26511-348
C48	0.01 µF ±2%	Wima 'M'	Switch SB	26511-312
C49	1000 pF ±2%	Lemco type 10	Switch SB	Y20641/29
C50	33 pF S. I. C.	L. E. M.	Switch SB	Y20641/14
C51	80 pF	L. E. M.	A7	Y20641/10
C52	47 pF	L. E. M.	A8	Y20641/15
C53	60 pF	L. E. M.	D8	Y20641/9
C54	1 µF ±2%	Wima 'M'	Switch SC	26511-381
C55	0.1 µF ±2%	Wima 'M'	Switch SC	26511-348
C56	0.01 µF ±2%	Wima 'M'	Switch SC	26511-312
C57	1000 pF S. I. C.	Lemco type 10	Switch SC	Y20641/29
C58	33 pF S. I. C.	L. E. M.	Switch SC	Y20641/14

Capacitors (continued)	Value	Description	Location on Diagram	Marconi Part No. TF 2010/FPP
C59	22 pF ±2%	L. E. M.	D8	Y20641/16
C60	1 μF	Dubilier	A9	26174-188
C61	10 pF	L. E. M.	A10	Y20641/17
C62	1 μF	Dubilier	B11	26174-188
C63	100 μF 25 V	Plessey	E11	Y20641/34
C64	0.1 μF	T. C. C.	E11	26582-208
C65	0.1 μF	T. C. C.	D9	26582-208
C66	100 μF 25 V	Plessey	F10	Y20643/34
C67	0.1 μF	T. C. C.	E9	26582-208
C68	80 pF	L. E. M.	C9	Y20641/10
C69	390 pF	L. E. M.	Fig. 2	Y20641/8
C70	60 pF S. I. C.	L. E. M.	Switch SB	Y20641/9
C71	220 pF	L. E. M.	Switch SA	Y20641/5
C72	0.1 μF		Fig. 2	X23914/27
C73	47 pF	Erie N750K	'Note'	Y50505/4
C74	33 pF	L. E. M.	Switch SA	Y20641/14
C77	560 pF	Lemco CT310K		Y50505/9
Diodes				
MR11	IS44	Texas	Amp. Board	28357-548
MR12	IS44	Texas	Amp. Board	28357-548
MR13	IS44	Texas	Amp. Board	28357-548
MR14	IS44	Texas	Amp. Board	28357-548
MR15	OA200	Semiconductors	E4	X20639/18
MR16	OA200	Semiconductors	F4	X20639/18
MR17	Unused			
MR18	OA200	Semiconductors	F3	X20639/18
MR19	OA200	Semiconductors	F3	X20639/18
MR20	OA200	Semiconductors	C4	X20639/18
MR21	OA200	Semiconductors	A6	X20639/18
MR22	OA200	Semiconductors	A6	X20639/18
MR23	IS44	Texas	C6	28357-548
MR24	IS44	Texas	C7	28357-548
MR25	IS44	Texas	D7	28357-548
MR26	IS44	Texas	D6	28357-548
MR27	IS44	Texas	D6	28357-548
MR28	OA200	Semiconductors	B7	X20639/18
MR29	OA200	Semiconductors	B7	X20639/18
MR30	IS44	Texas	A8	28357-548
MR31	IS44	Texas	B8	28357-548
MR32	IS44	Texas	C8	28357-548
MR33	BZY88/C10	Mullard	B9	X20639/57
MR34	IS44	Texas	C9	28357-548
MR35	IS44	Texas	C9	28357-548
MR36	IS44	Texas	D11	28357-548
MR37	IS44	Texas	B9	28357-548
MR38	IS44	Texas	B9	28357-548
MR39	IS44	Texas	D10	28357-548

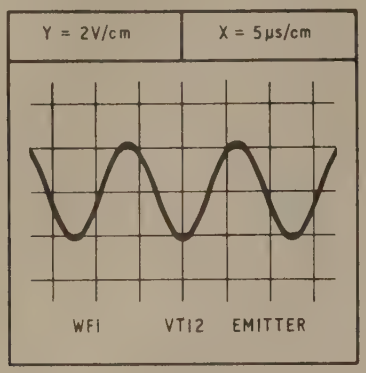
Resistors	Value			Description	Location on Diagram	Marconi Part No. TF 2010/FPP
R22	1.5 kΩ	±10%	½ W	Dubilier, BTT	Atten. Board	24342-084
R23	100 Ω	±5%	¼ W	Hi Stab.	" "	24232-050
R24	120 Ω	±5%	¼ W	" "	" "	24232-052
R25	120 Ω	±5%	¼ W	" "	" "	24232-052
R26	82 Ω	±5%	¼ W	" "	" "	24132-820
R28	1.5 kΩ	±10%	¼ W	Dubilier, BTT	C4	24342-084
R29	330 Ω	±10%	¼ W	"	B3	24342-063
R30	100 Ω	±5%	¼ W	Hi Stab.	C2	24232-050
R31	330 Ω	±5%	½ W	Dubilier, BTT	C1	24342-063
R32	3.3 kΩ	±5%	½ W	"	B1	24342-094
R33	47 Ω	±5%	½ W	"	B3	24342-037
R34	3.3 kΩ	±5%	½ W	"	B3	24342-094
R35	820 Ω	±5%	½ W	"	B3	24342-078
R36	330 Ω	±5%	½ W	"	B3	24342-063
R37	1 kΩ	±5%	½ W	"	B4	24342-080
R38	270 Ω	±5%	½ W	"	B4	24342-061
R39	1 kΩ	±5%	½ W	"	B3	24342-080
R40	1.8 kΩ	±5%	2 W	Radio Resistor '0'	E1	Z50256
R41	470 Ω	±5%	½ W	Dubilier, BTT	D1	24342-069
R42	33 kΩ	±10%	½ W	Dubilier, BTT	E4	24342-122
R43	22 kΩ	±10%	½ W	"	F4	24342-118
R44	1 kΩ	±10%	½ W	"	F4	24342-080
R45	2.7 kΩ	±10%	½ W	"	F3	24342-092
R46	1.8 kΩ	±5%	¼ W	Hi Stab.	F3	24232-086
R47	7.5 kΩ	±5%	¼ W	" "	E3	24134-750
R48	330 Ω	±5%	¼ W	" "	D4	24232-063
R49	33 Ω	±5%	¼ W	" "	D4	24232-033
R50	2.2 kΩ	±10%	½ W	Dubilier, BTT	D3	24342-088
R51	3.3 kΩ	±10%	½ W	"	D3	24342-094
R52	220 Ω	±10%	1 W	Dubilier, BTA	E3	24343-058
R53	3.3 kΩ	±10%	½ W	" , BTT	D3	24342-094
R54	330 Ω	±10%	½ W	"	D3	24342-063
R55	6.8 kΩ	±10%	½ W	"	A6	24342-106
R56	560 Ω	±10%	½ W	"	A6	24342-072
R57	330 Ω	±10%	½ W	"	B6	24342-063
R58	3.3 kΩ	±10%	½ W	"	C6	24342-094
R59	1 kΩ	±10%	½ W	"	B6	24342-080
R60	470 Ω	±10%	½ W	"	C6	24342-069
R61	10 kΩ	±10%	½ W	"	Fig. 2	24342-110
R62	3.3 kΩ	±10%	½ W	"	B7	24342-094
R63	330 Ω	±10%	½ W	"	C7	24342-063
R64	3.3 kΩ	±10%	½ W	"	C6	24342-094
R65	330 Ω	±10%	½ W	"	D6	24342-063
R66	33 kΩ	±10%	½ W	"	D5	24342-122
R67	470 Ω	±10%	½ W	"	D6	24342-069
R68	5.6 kΩ	±10%	½ W	"	D5	24342-103
R69	330 Ω	±10%	1 W	Dubilier, BTA	D6	24343-063
R70	100 Ω	±10%	¼ W	Erie EM2	E5	X50500/25
R71	3.6 kΩ	±10%	¼ W	Erie EM2	E6	X50500/62
R72	3.3 kΩ	±10%	½ W	Dubilier BTT	A7	24342-094
R73	330 kΩ	±10%	½ W	"	A7	24342-063
R74	3.3 kΩ	±10%	½ W	"	A8	24342-094
R75	330 kΩ	±10%	½ W	"	B8	24342-063

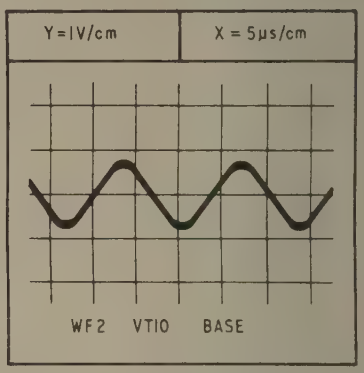
Resistors (cont.)	Value			Description	Location on Diagram	Marconi Part No. TF 2010/FPP
R76	1 kΩ	±10%	½ W	Dubilier, BTT	B8	24342-080
R77	270 Ω	±10%	1 W	Dubilier, BTA	C7	24343-061
R78	33 kΩ	±10%	½ W	Dubilier, BTT	D8	24342-122
R79	5.6 kΩ	±10%	½ W	"	C8	24342-103
R80	330 Ω	±10%	1 W	Dubilier, BTA	C8	24343-063
R81	100 Ω	±10%	¼ W	Erie EM2	E8	X50500/25
R82	3.6 kΩ	±10%	¼ W	Erie EM2	D8	X50500/62
R83	2.2 kΩ	±10%	½ W	Dubilier, BTT	C8	24342-088
R84	560 Ω	±10%	½ W	"	D8	24342-072
R85	220 Ω	±10%	1 W	Dubilier, BTA	B8	24343-058
R86	2.2 kΩ	±10%	½ W	Dubilier, BTT	A10	24342-088
R87	560 Ω	±10%	½ W	"	B10	24342-072
R88	220 Ω	±10%	1 W	Dubilier, BTA	B10	24343-058
R89	220 Ω	±10%	½ W	Dubilier, BTT	B10	24342-058
R90	150 Ω	±10%	½ W	"	C10	24342-054
R91	47 Ω	±10%	1 W	Dubilier, BTA	C10	24343-037
R92	100 Ω	±10%	2 W	Radio Resistor, '0'	C11	Z50257
R93	82 Ω	±10%	½ W	Dubilier, BTT	C11	24342-046
R94	82 Ω	±10%	½ W	"	D11	24342-046
R95	100 Ω	±10%	6 W	Welwyn, F76	E11	Y50235
R96	270 Ω	±10%	½ W	Dubilier, BTT	B9	24342-061
R97	82 Ω	±10%	½ W	"	B9	24342-046
R98	47 Ω	±10%	1 W	Dubilier, BTA	C9	24343-037
R99	100 Ω	±10%	2 W	Radio Resistor, '0'	D9	Z50257
R100	82 Ω	±10%	½ W	Dubilier, BTT	D10	24342-046
R101	82 Ω	±10%	½ W	"	D10	24342-046
R102	100 Ω	±10%	6 W	Welwyn, F76	E10	Y50235
R103	56 Ω	±10%	1 W	Dubilier, BTA	Switch SD	24343-040
R104	91 Ω	±5%	¼ W	Hi Stab.	" "	X50500/24
R105	82 Ω	±5%	¼ W	" "	" "	24132-820
R106	82 Ω	±5%	¼ W	" "	" "	24132-820
R107	470 Ω	±5%	¼ W	Hi Stab.		X50500/41
R108	220 Ω	±5%	¼ W	Hi Stab.		X50500/33
R109	270 Ω					X50500/35
Resistors Variable						
RV6	1 kΩ				C3	25611-114
RV7	1 kΩ				C3	25611-114
RV8*	10 kΩ				Switch SA	X20999/33
RV9*	10 kΩ				Switch SA	Ganged
RV10	68 kΩ				E4	25611-136
RV11	15 kΩ	±5%			Switch SB	25611/42
RV12	1 kΩ				F6	25611-114
RV13	1 kΩ				F5	25611-114
RV14	1 kΩ				E5	25611-114
RV15	1 kΩ				E6	25611-114
RV16	15 kΩ	±5%			Switch SC	X20999/42
RV17	1 kΩ				F8	25611-114
RV18	1 kΩ				F8	25611-114
RV19	1 kΩ				E8	25611-114
RV20	1 kΩ				E8	25611-114
RV21	1 kΩ				C11	25611-114
RV22	1 kΩ				D10	25611-114
RV23	1 kΩ				C2	25611-114
RV24	1 kΩ				C1	25611-114
RV25	6.8 kΩ				A3	X20999/32

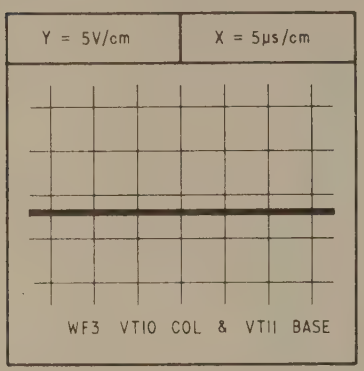
Socket	Value	Description	Location on Diagram	Marconi Part No. TF 2010/FPP
SKTA	B.N.C., 50 Ω			23443-443
SKTB	B.N.C., 50 Ω			23443-443
SKTC	B.N.C., 50 Ω			23443-443
Switch				
SA				Y50237
SB				Y50238
SC				Y50238
SD				Y50239
SE				Y50240
SF				Z27067
SG				Z27067
SH				X50296
Thermistors				
TH1	R52	S.T.C.	B4	Y23955/5
TH2	R23	S.T.C.	B4	Y23955/3
Transistors				
VT10	BSY38		A3	X20638/59
VT11	V405A	Fairchild	A3	X20638/65
VT12	BSY38		A3	X20638/59
VT13	BSY38		E3	X20638/59
VT14	BSY95A	S.T.C.	D3	X20638/56
VT15	BSY38		E3	X20638/59
VT16	BSY38		C3	X20638/59
VT17	BSY38		A6	X20638/59
VT18	BSY38		A6	X20638/59
VT19	BSY38		C6	X20638/59
VT20	BSY38		C7	X20638/59
VT21	BSY38		D6	X20638/59
VT22	BSY38		D6	X20638/59
VT23	BSY95A*	S.T.C.	D6	X20638/56
VT24	BSY38		A8	X20638/59
VT25	BSY38		B8	X20638/59
VT26	BSY95A*	S.T.C.	C8	X20638/56
VT27	BSY95A*	S.T.C.	D8	X20638/56
VT28	BSY38		C8	X20638/59
VT29	BSY38		B9	X20638/59
VT30	BSY38		C10	X20638/59
VT31	MM1613	Motorola	D11	X20638/49
VT32	V205	Fairchild	C9	X20638/62
VT33	MM3726	Motorola	E9	X20638/84

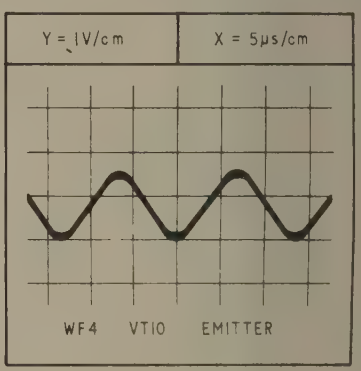
* Selected: Beta greater than 60.

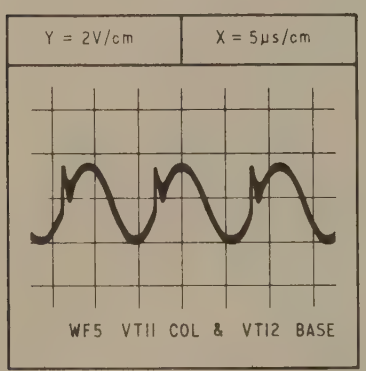
WAVEFORMS 1-5
DGM. NO. S 63/70

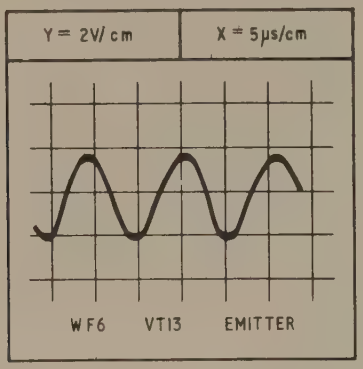

Y = 2V/cm
X = 5µs/cm
WF1 VT12 EMITTER

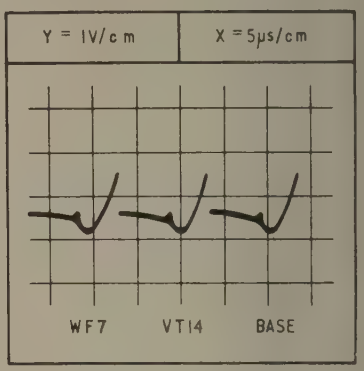

Y=1V/cm
X = 5µs/cm
WF2 VT10 BASE

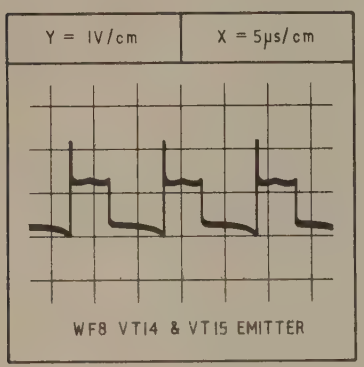

Y = 5V/cm
X = 5µs/cm
WF3 VT10 COL & VT11 BASE

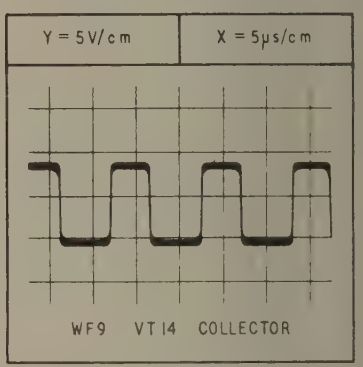

Y = 1V/cm
X = 5µs/cm
WF4 VT10 EMITTER

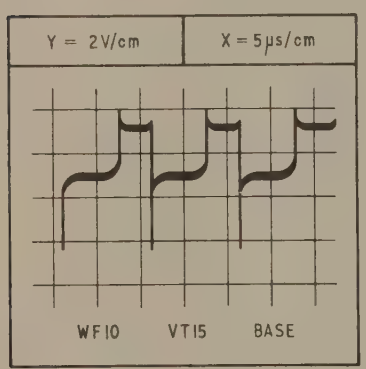

Y = 2V/cm
X = 5µs/cm
WF5 VT11 COL & VT12 BASE

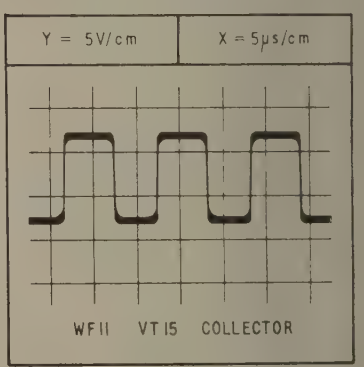

Y = 2V/cm
X = 5µs/cm
WF6 VT13 EMITTER

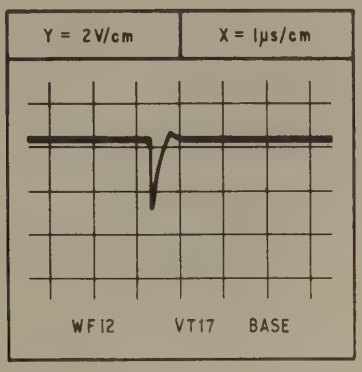

Y = 1V/cm
X = 5µs/cm
WF7 VT14 BASE

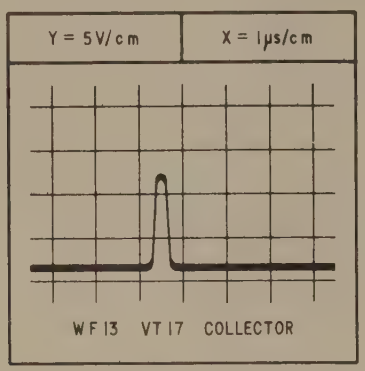

Y = 1V/cm
X = 5µs/cm
WF8 VT14 & VT15 EMITTER

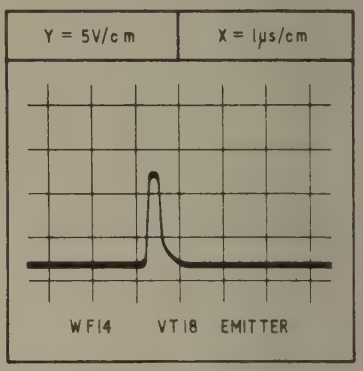

Y = 5V/cm
X = 5µs/cm
WF9 VT14 COLLECTOR

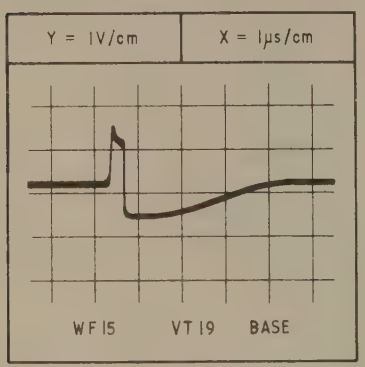

Y = 2V/cm
X = 5µs/cm
WF10 VT15 BASE

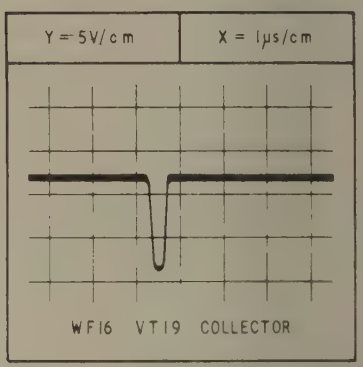

Y = 5V/cm
X = 5µs/cm
WF11 VT15 COLLECTOR

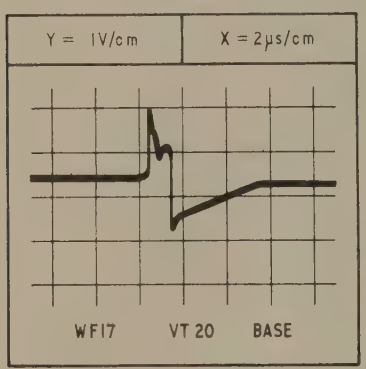

Y = 2V/cm
X = 1μs/cm
WF12
VT17
BASE

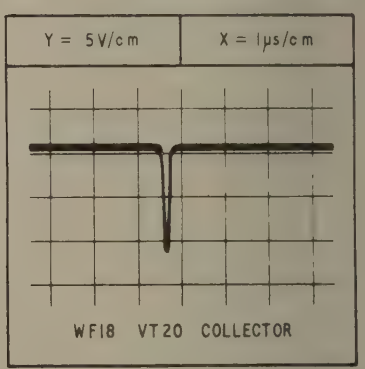

Y = 5V/cm
X = 1μs/cm
WF13 VT17 COLLECTOR

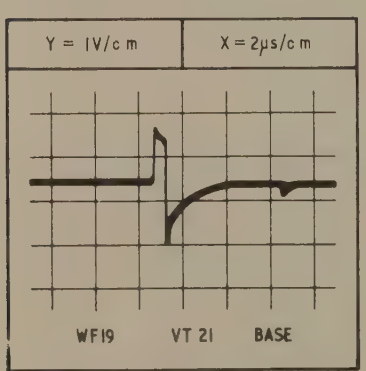

Y = 5V/cm
X = 1μs/cm
WF14 VT18 EMITTER

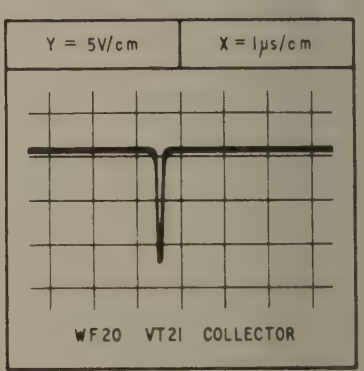

Y = 1V/cm
X = 1μs/cm
WF15 VT19 BASE

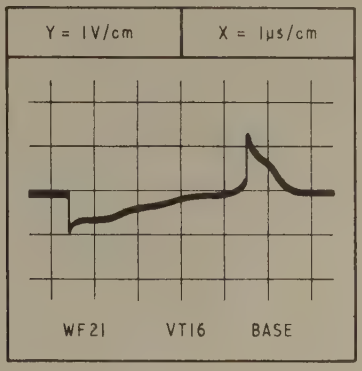

Y = 5V/cm
X = 1μs/cm
WF16 VT19 COLLECTOR

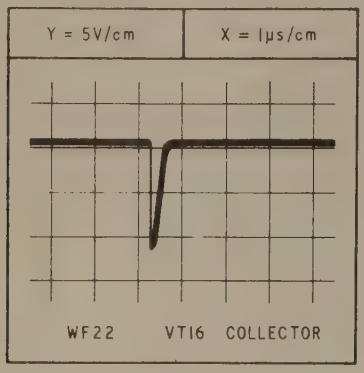

Y = 1V/cm
X = 2μs/cm
WF17 VT20 BASE

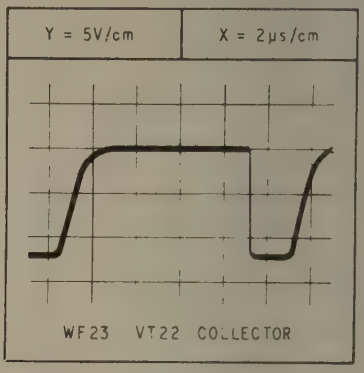

Y = 5V/cm
X = 1μs/cm
WF18 VT20 COLLECTOR

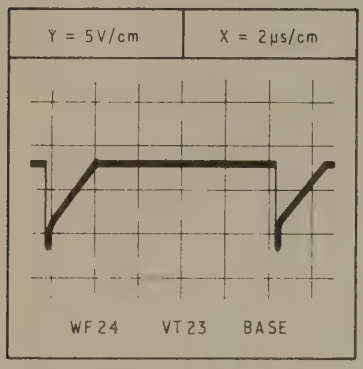

Y = 1V/cm
X = 2μs/cm
WF19 VT21 BASE

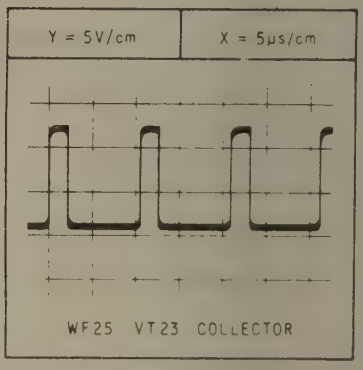

Y = 5V/cm
X = 1μs/cm
WF20 VT21 COLLECTOR

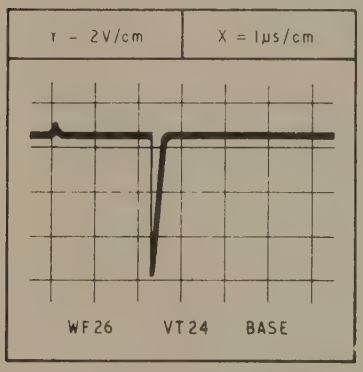

Y = 1V/cm
X = 1μs/cm
WF21
VT16
BASE

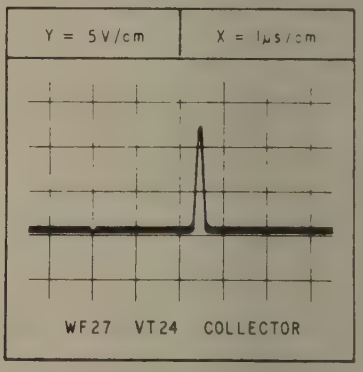

Y = 5V/cm
X = 1µs/cm
WF22 VT16 COLLECTOR

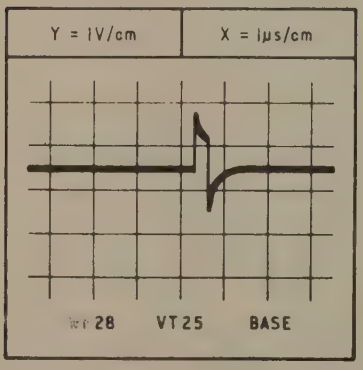

Y = 5V/cm
X = 2µs/cm
WF23 VT22 COLLECTOR

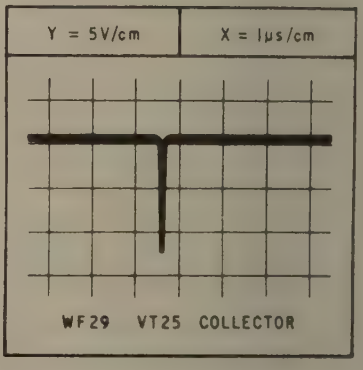

Y = 5V/cm
X = 2µs/cm
WF24 VT23 BASE


Y = 5V/cm
X = 5µs/cm
WF25 VT23 COLLECTOR

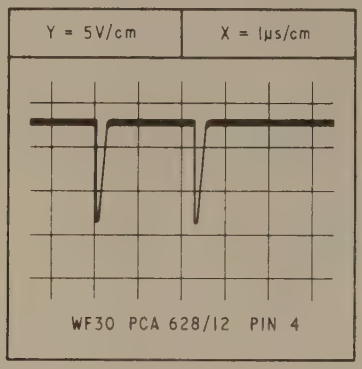

Y = 2V/cm
X = 1µs/cm
WF26 VT24 BASE

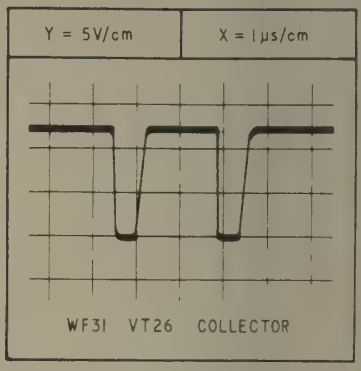

Y = 5V/cm
X = 1µs/cm
WF27 VT24 COLLECTOR

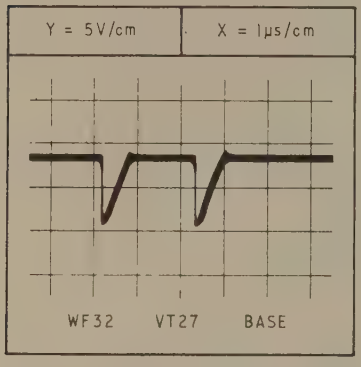

Y = 1V/cm
X = 1µs/cm
WF28 VT25 BASE

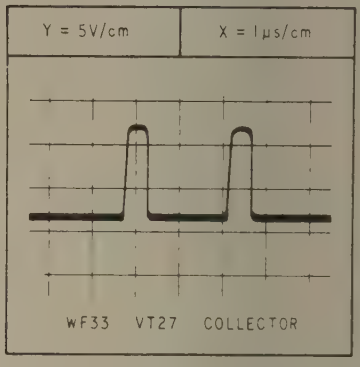

Y = 5V/cm
X = 1µs/cm
WF29 VT25 COLLECTOR

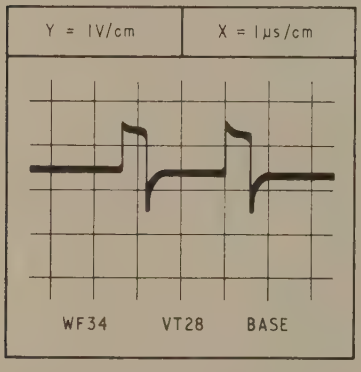
WAVEFORMS 30-37
DGM. NO. S 63/74

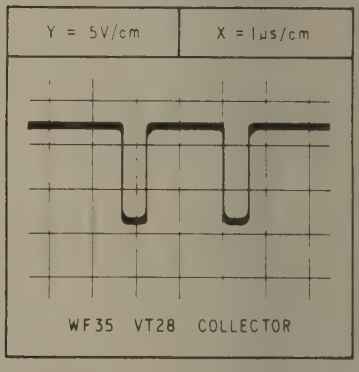

Y = 5V/cm
X = 1µs/cm
WF30 PCA 628/12 PIN 4

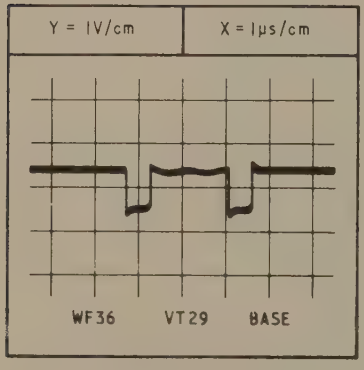

Y = 5V/cm
X = 1µs/cm
WF31 VT26 COLLECTOR

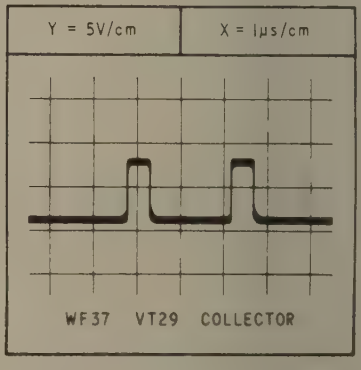

Y = 5V/cm
X = 1µs/cm
WF32 VT27 BASE

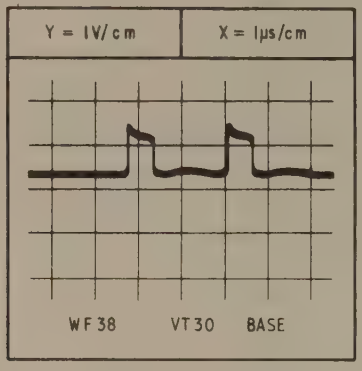

Y = 5V/cm
X = 1µs/cm
WF33 VT27 COLLECTOR

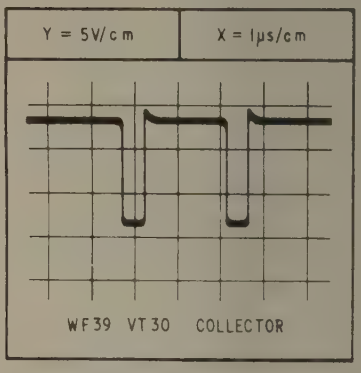

Y = 1V/cm
X = 1µs/cm
WF34 VT28 BASE

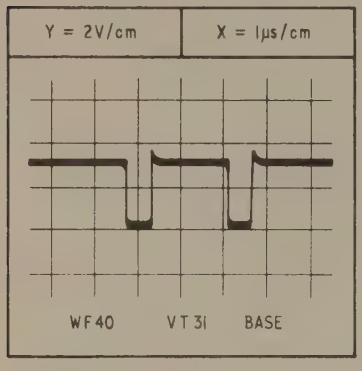

Y = 5V/cm
X = 1µs/cm
WF35 VT28 COLLECTOR

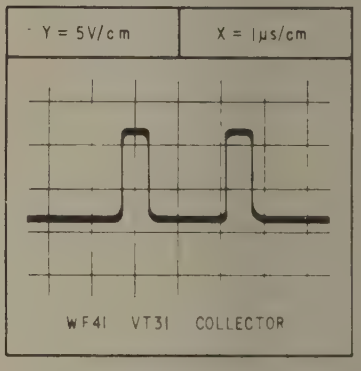

Y = 1V/cm
X = 1µs/cm
WF36 VT29 BASE

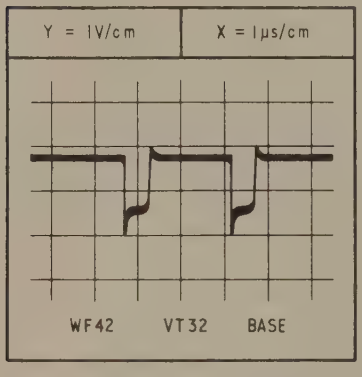

Y = 5V/cm
X = 1µs/cm
WF37 VT29 COLLECTOR

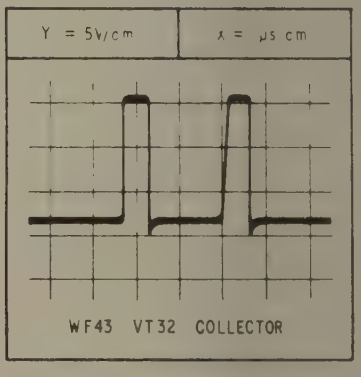

Y = 1V/cm
X = 1µs/cm
WF38 VT30 BASE

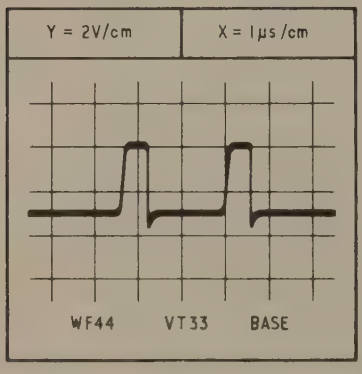

Y = 5V/cm
X = 1µs/cm
WF39 VT30 COLLECTOR

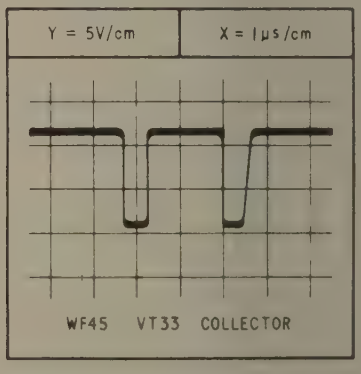

Y = 2V/cm
X = 1µs/cm
WF40 VT31 BASE

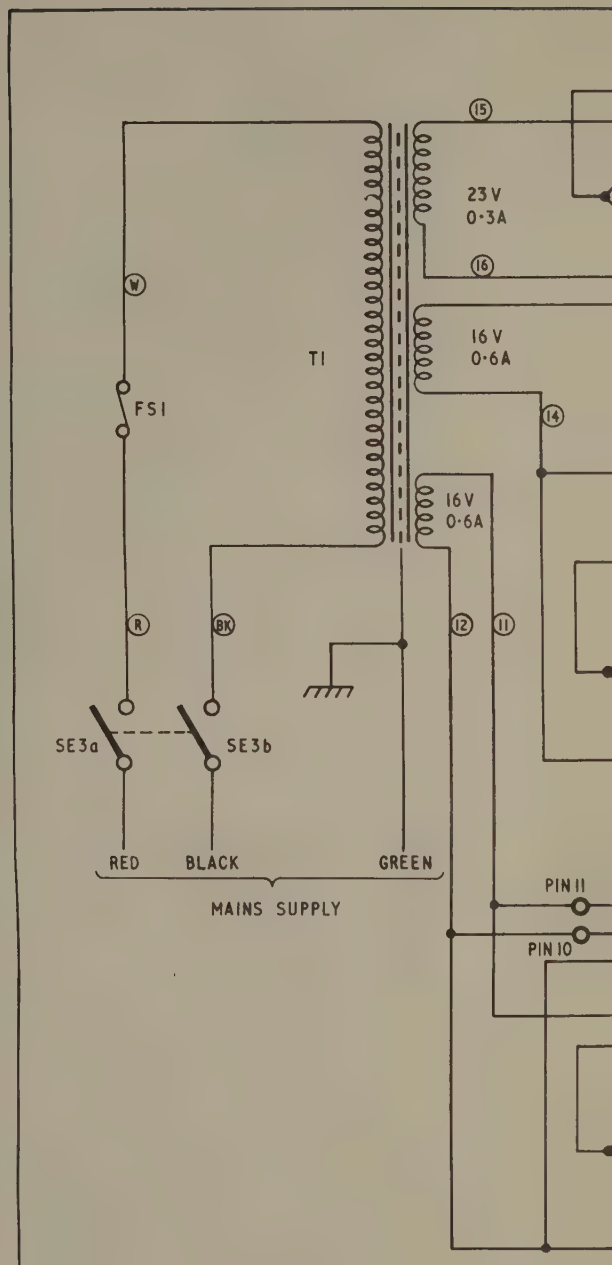

Y = 5V/cm
X = 1µs/cm
WF41 VT31 COLLECTOR

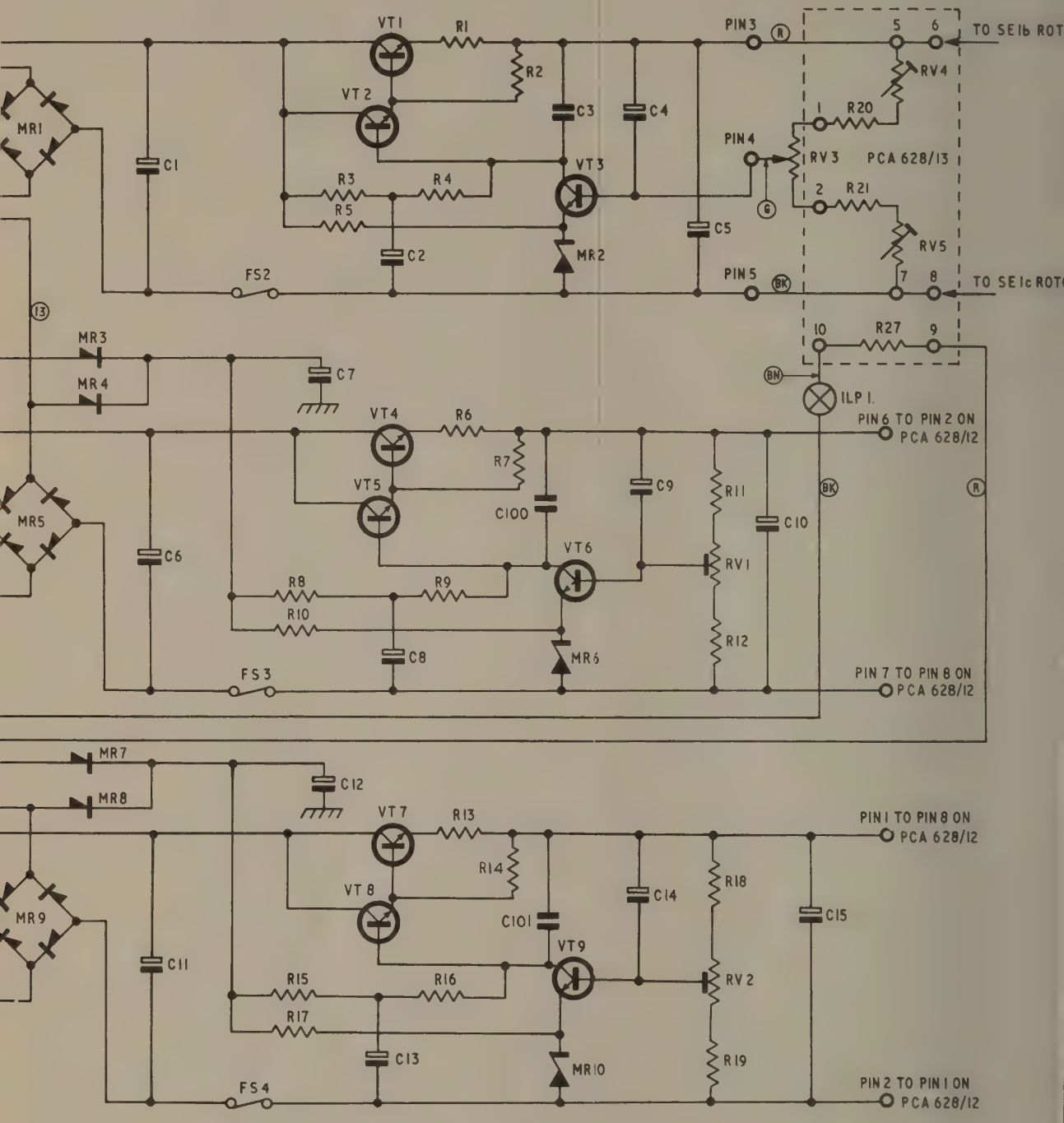

Y = 1V/cm
X = 1µs/cm
WF42 VT32 BASE


Y = 5V/cm
WF43 VT32 COLLECTOR


Y = 2V/cm
X = 1µs/cm
WF44 VT33 BASE


Y = 5V/cm
X = 1µs/cm
WF45 VT33 COLLECTOR


15
23 V
0·3A
16
W
T1
16 V
0·6A
FS1
14
16 V
0·6A
R
BK
12
11
SE3a
SE3b
RED
BLACK
GREEN
MAINS SUPPLY
PIN 11
PIN 10



POWER SUPPLY
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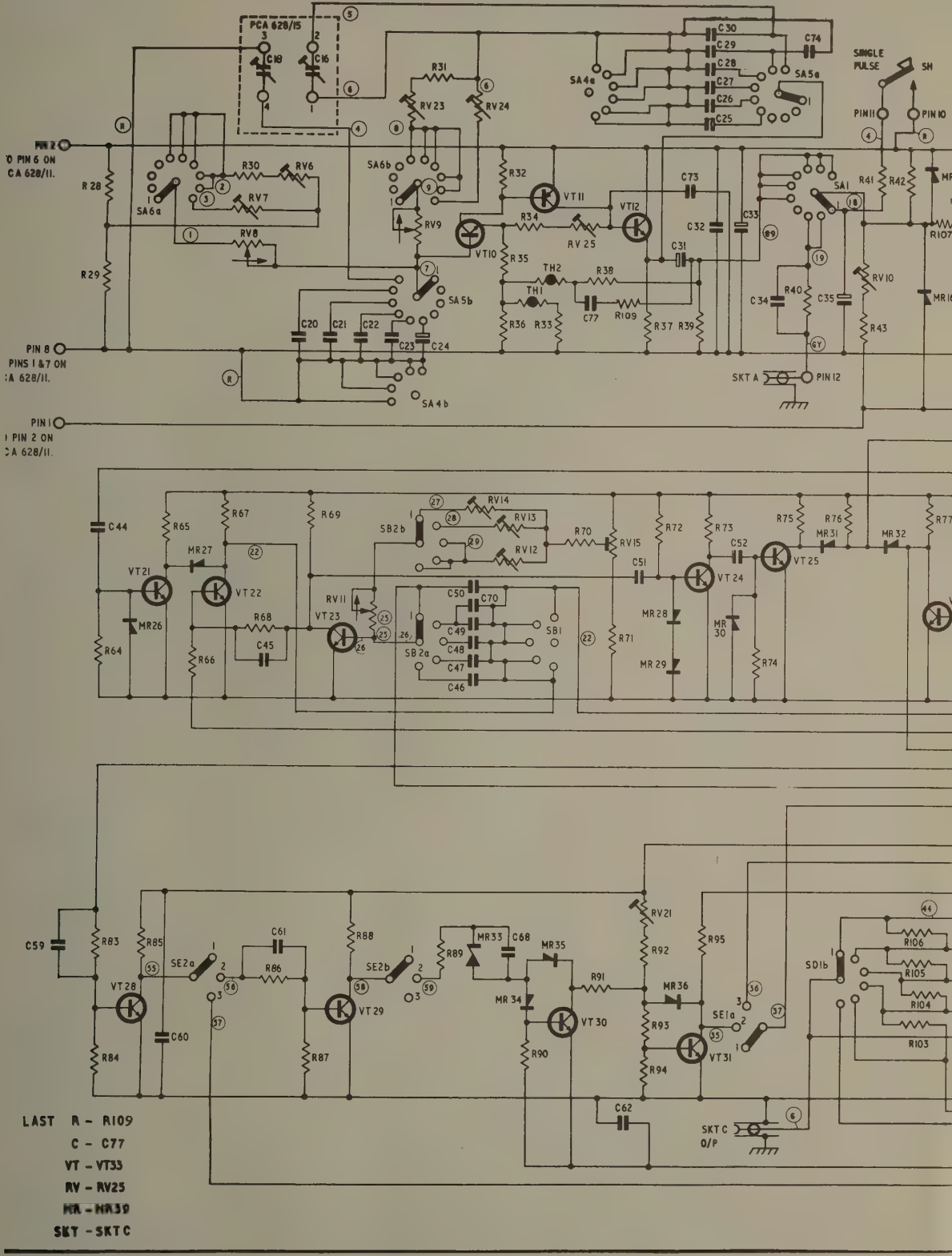
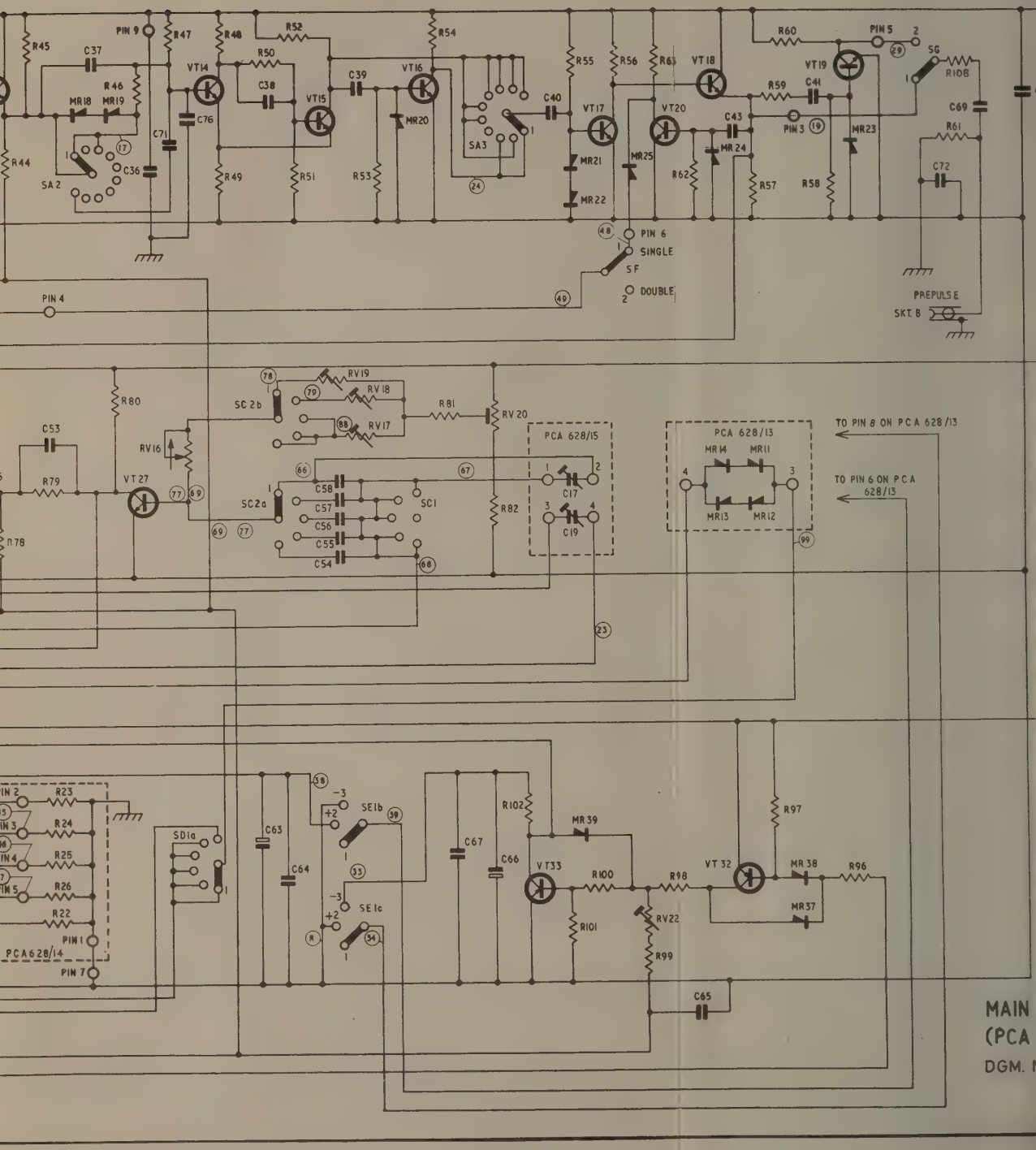


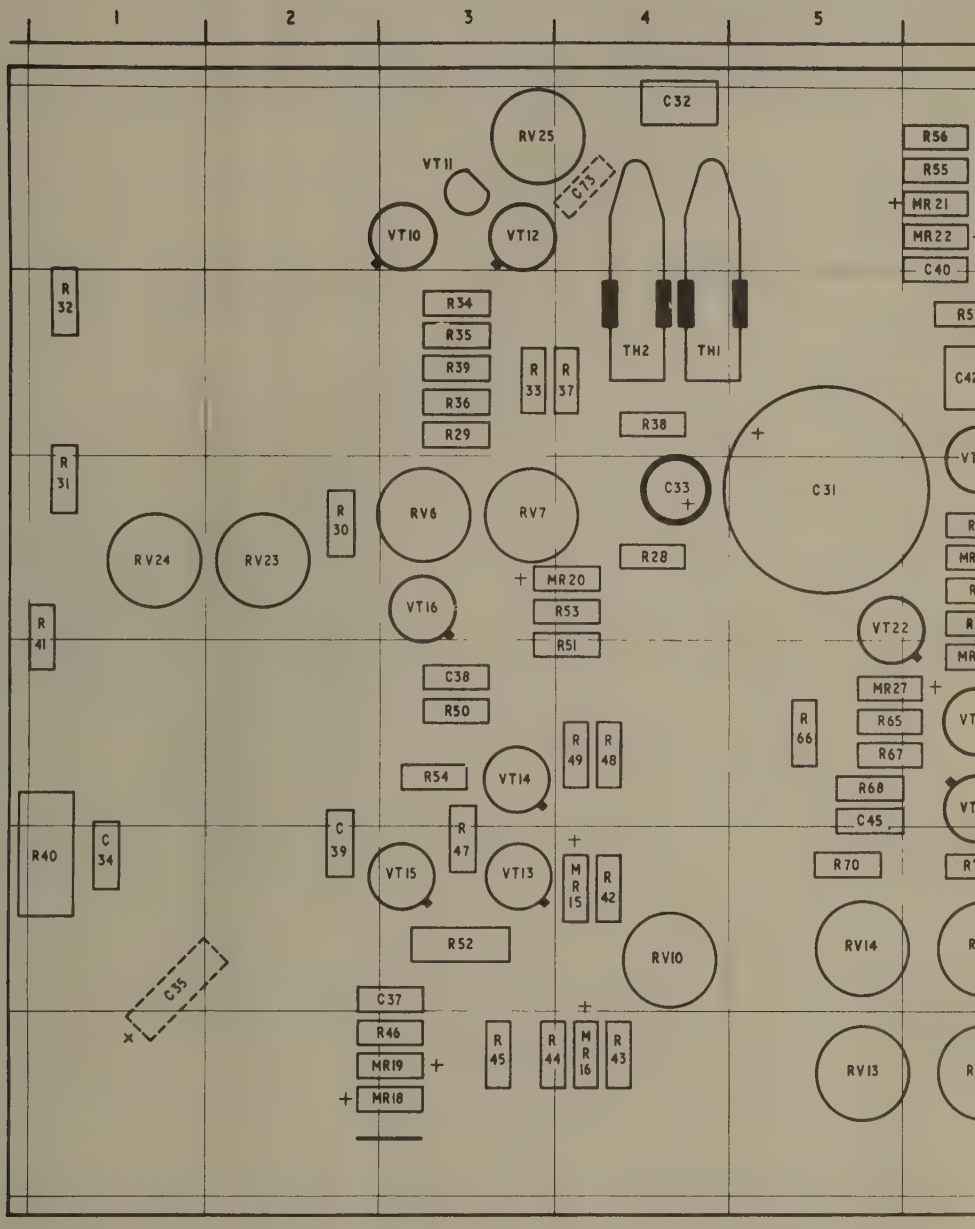
LAST R - R109
C - C77
VT - VT33
RV - RV25
MR - MR39
SKT - SKT C

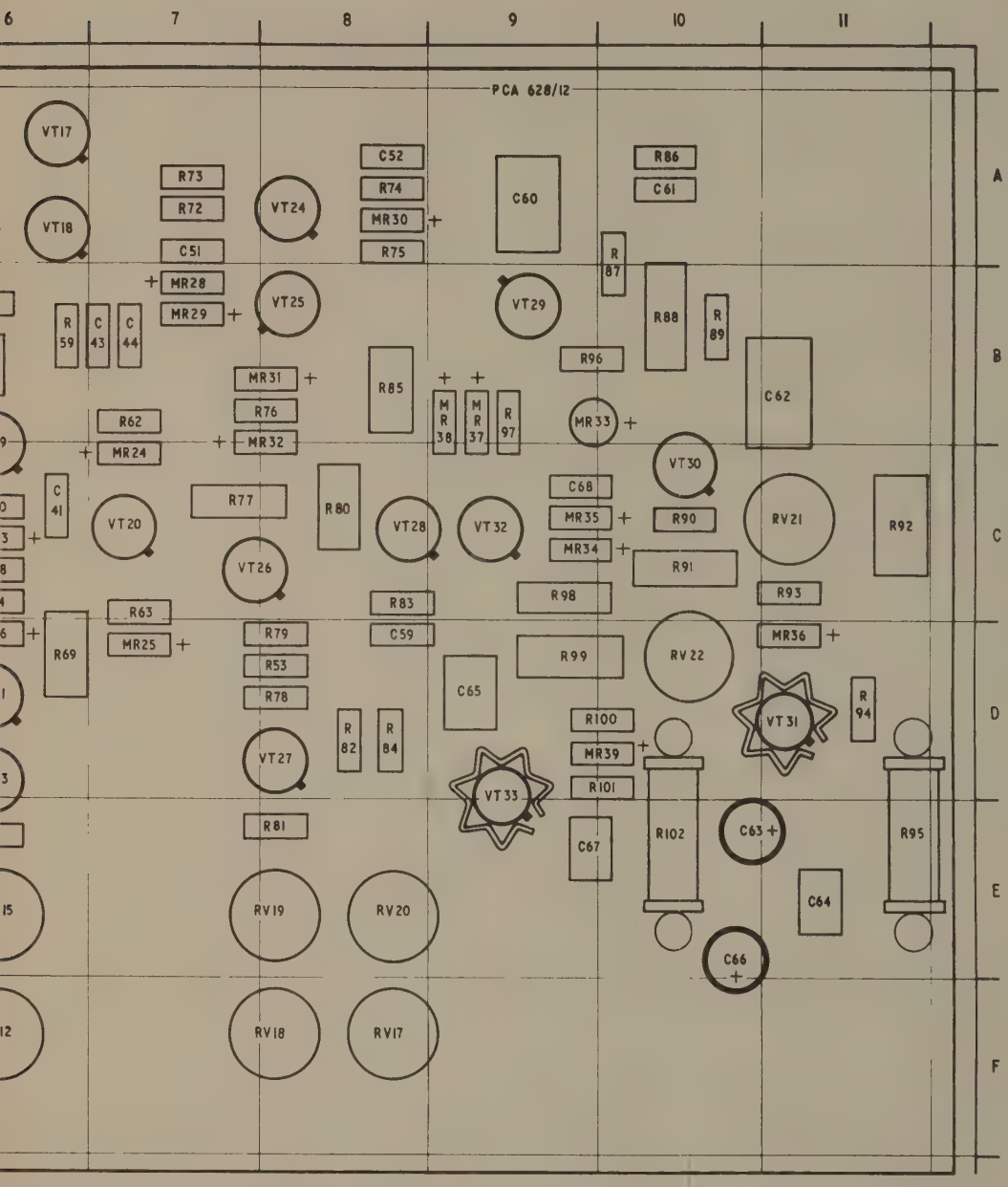

PIN 9
R45
C37
R46
MR18
MR19
R47
R48
R52
R50
C38
VT14
VT15
VT16
C39
MR20
R54
SA3
C40
R55
R56
R63
VT18
VT17
VT20
MR21
MR22
MR25
R62
R57
R58
C43
MR24
R59
C41
VT19
R60
PIN 5
PIN 3
MR23
SG
R108
C69
R61
C72
PREPULSE
SKT 8
C71
C76
R44
SA 2
C36
R49
R51
R53
PIN 6
SINGLE
SF
DOUBLE
PIN 4
R80
C53
RV16
R79
VT 27
SC 2b
SC 2a
RV19
RV18
RV17
R81
RV 20
SC1
C58
C57
C56
C55
C54
R82
PCA 628/15
C17
C19
PCA 628/13
MR14
MR11
MR13
MR12
TO PIN 8 ON PCA 628/13
TO PIN 6 ON PCA 628/13
R23
R24
R25
R26
R22
PIN 1
PIN 7
PCA 628/14
SDia
C63
C64
SE1b
SE1c
C67
C66
R102
MR39
VT33
R100
R101
RV22
R99
R98
VT 32
MR38
MR37
R96
R97
C65

MAIN
(PCA
DGM.

TF 2010

ARD
3/12)
ES66/12


1
2
3
4
5
C32
RV25
VT11
C13
VT10
VT12
R56
R55
MR21
MR22
C40
R32
R34
R35
R39
R36
R29
R33
R37
TH2
TH1
R38
R31
C33
C31
RV6
RV7
R30
RV24
RV23
R28
MR20
VT16
R53
R51
VT22
R41
C38
R50
MR27
R65
R67
R66
R49
R48
R54
VT14
R68
C45
R40
C34
C39
R47
VT15
VT13
MR15
R42
R70
RV10
RV14
R52
C35
C37
R46
MR19
MR18
R45
R44
MR16
R43
RV13



MAIN BOARD LAYOUT

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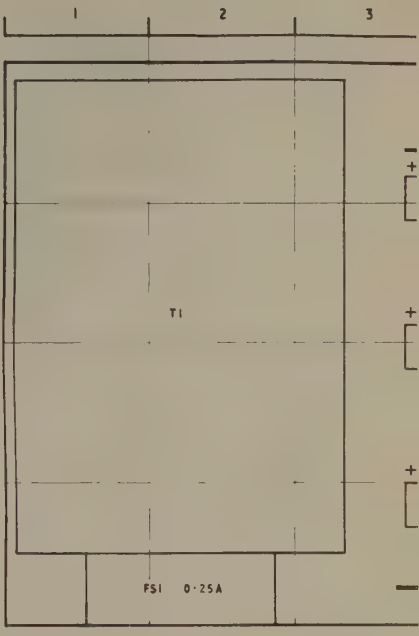
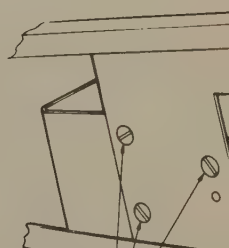

1
2
3
T1
FSI 0·25A


A

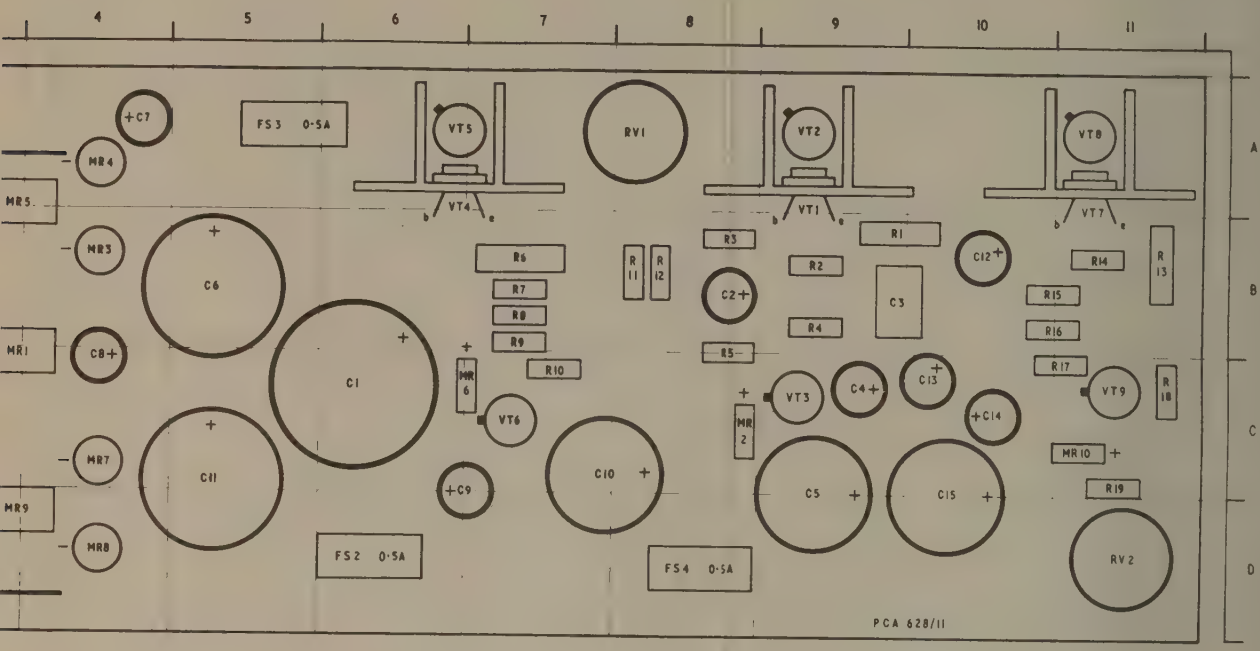


FIG.1

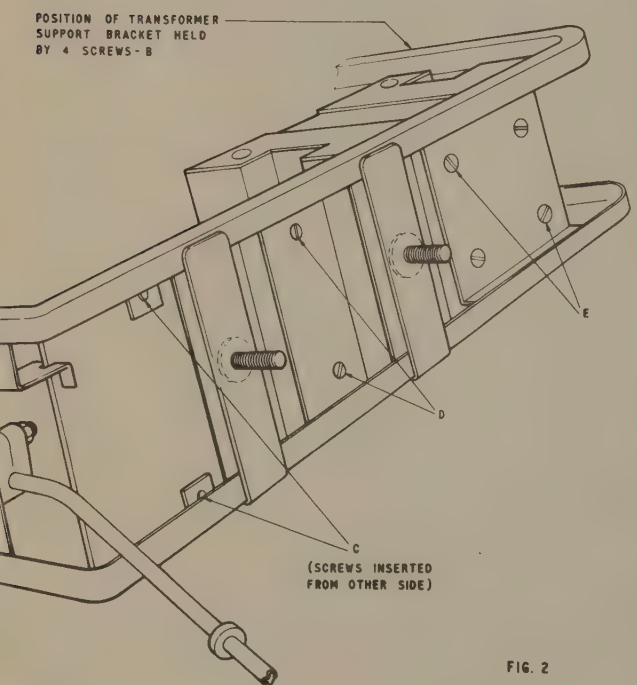
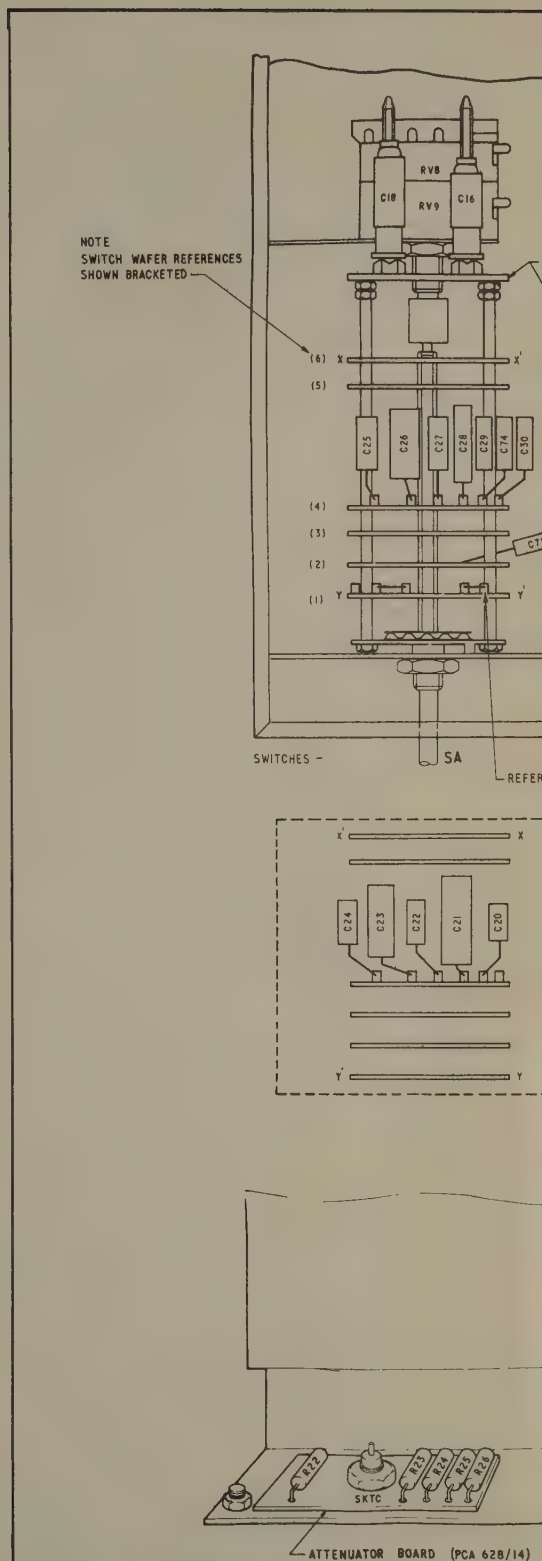
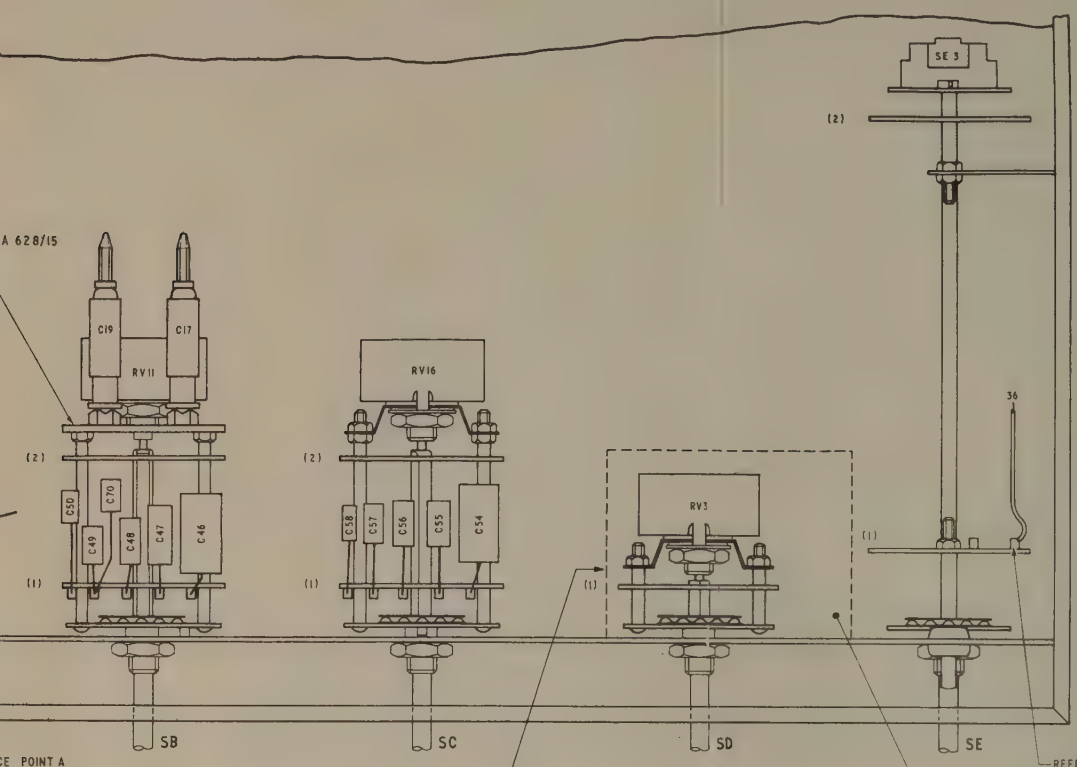


FIG. 2

FIG. 1 POWER SUPPLY BOARD
FIG. 2 REAR VIEW OF FRAME
DGM. NO. S63/51


NOTE
SWITCH WAFER REFERENCES
SHOWN BRACKETED
RV8
RV9
C18
C16
(6) X
X'
(5)
C25
C26
C27
C28
C29
C74
C30
(4)
(3)
(2)
(1) Y
Y'
SWITCHES -
SA
REFER
C24
C23
C22
C21
C20
R22
SKTC
R23
R24
R25
R26
ATTENUATOR BOARD (PCA 628/14)



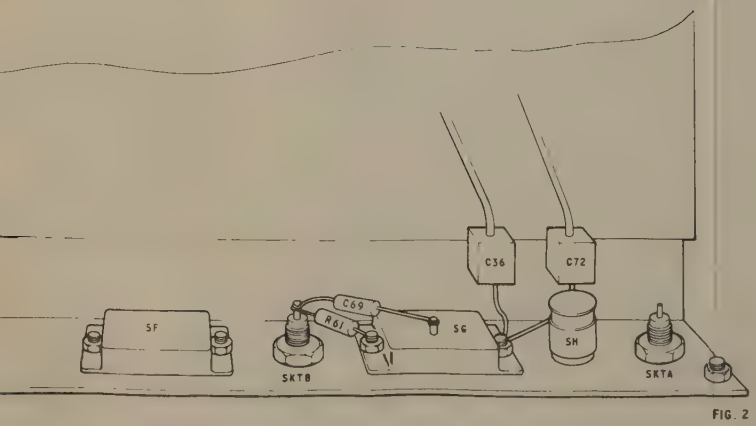


FIG. 2

FIG. 1 ROTARY CONTROLS LAYOUT

FIG. 2 UNDER-CHASSIS FRONT-PANEL-MOUNTED COMPONENTS LAYOUT

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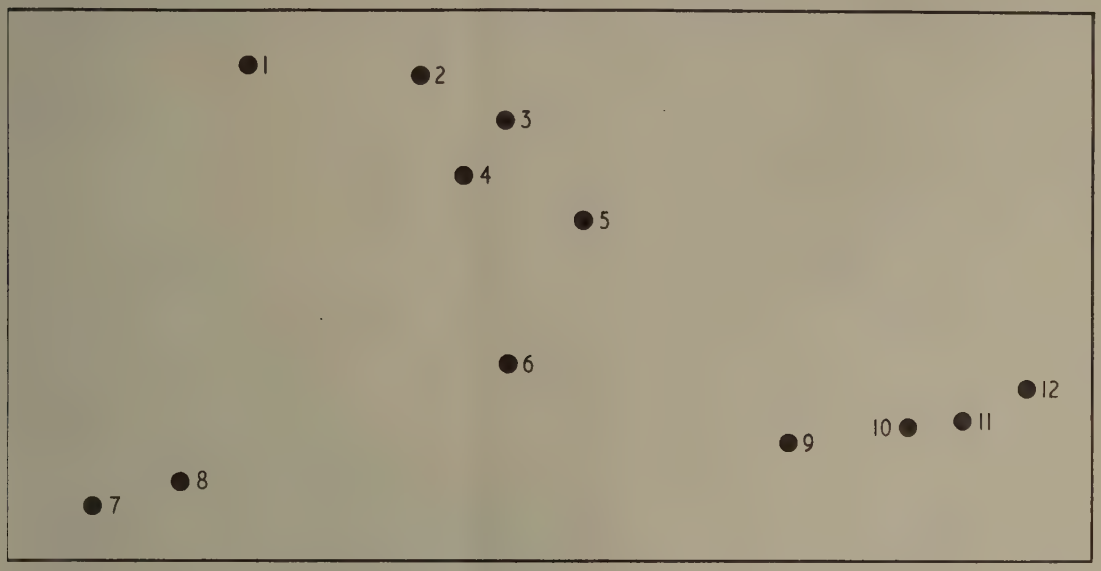
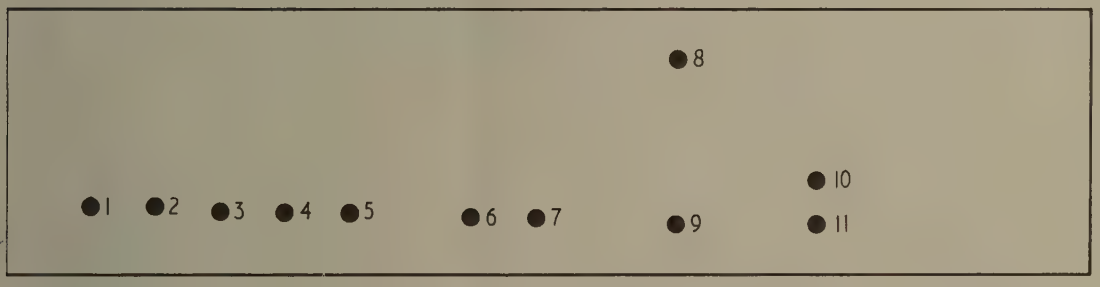


COPPER SIDE OF BOARD

FIG. 1

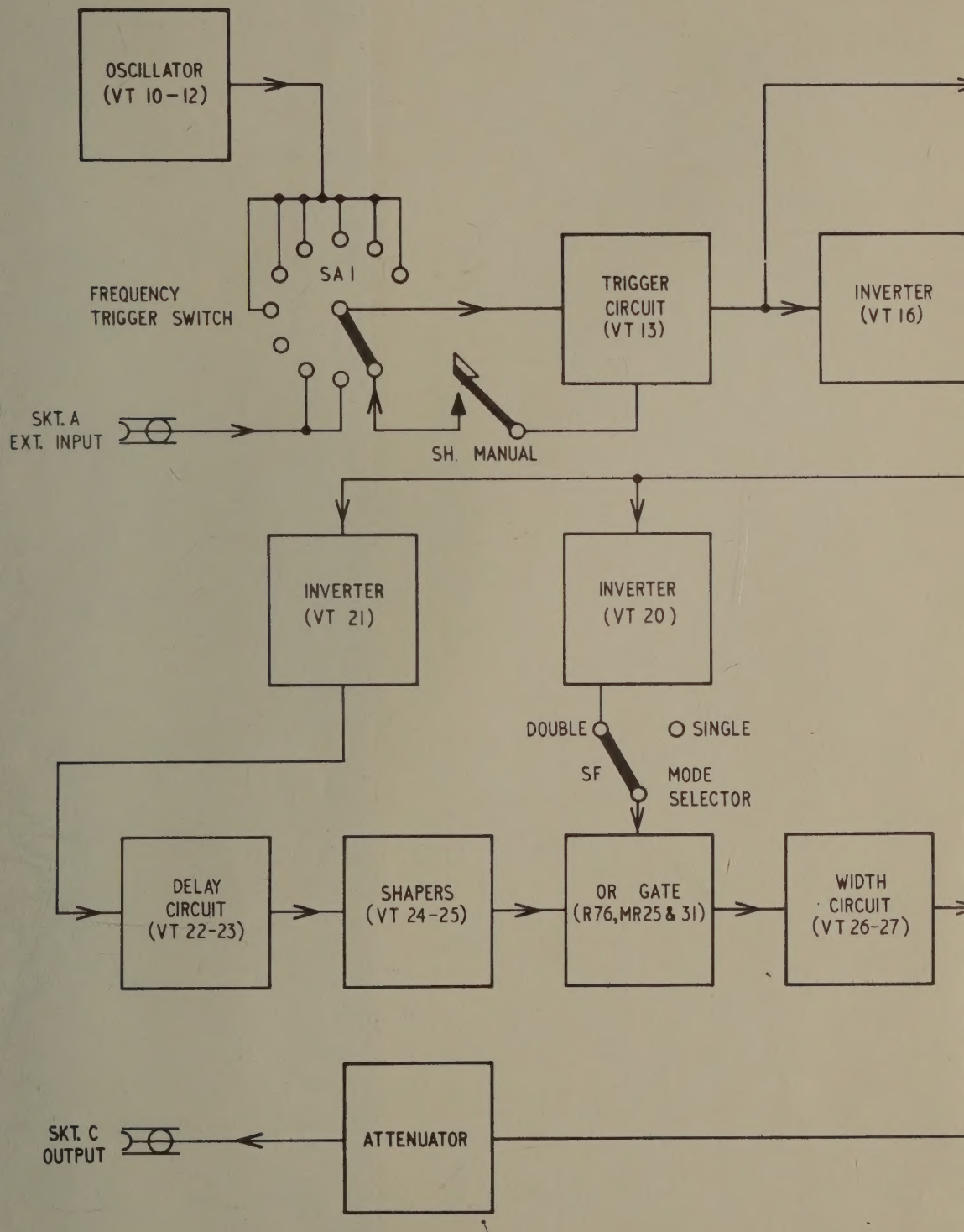


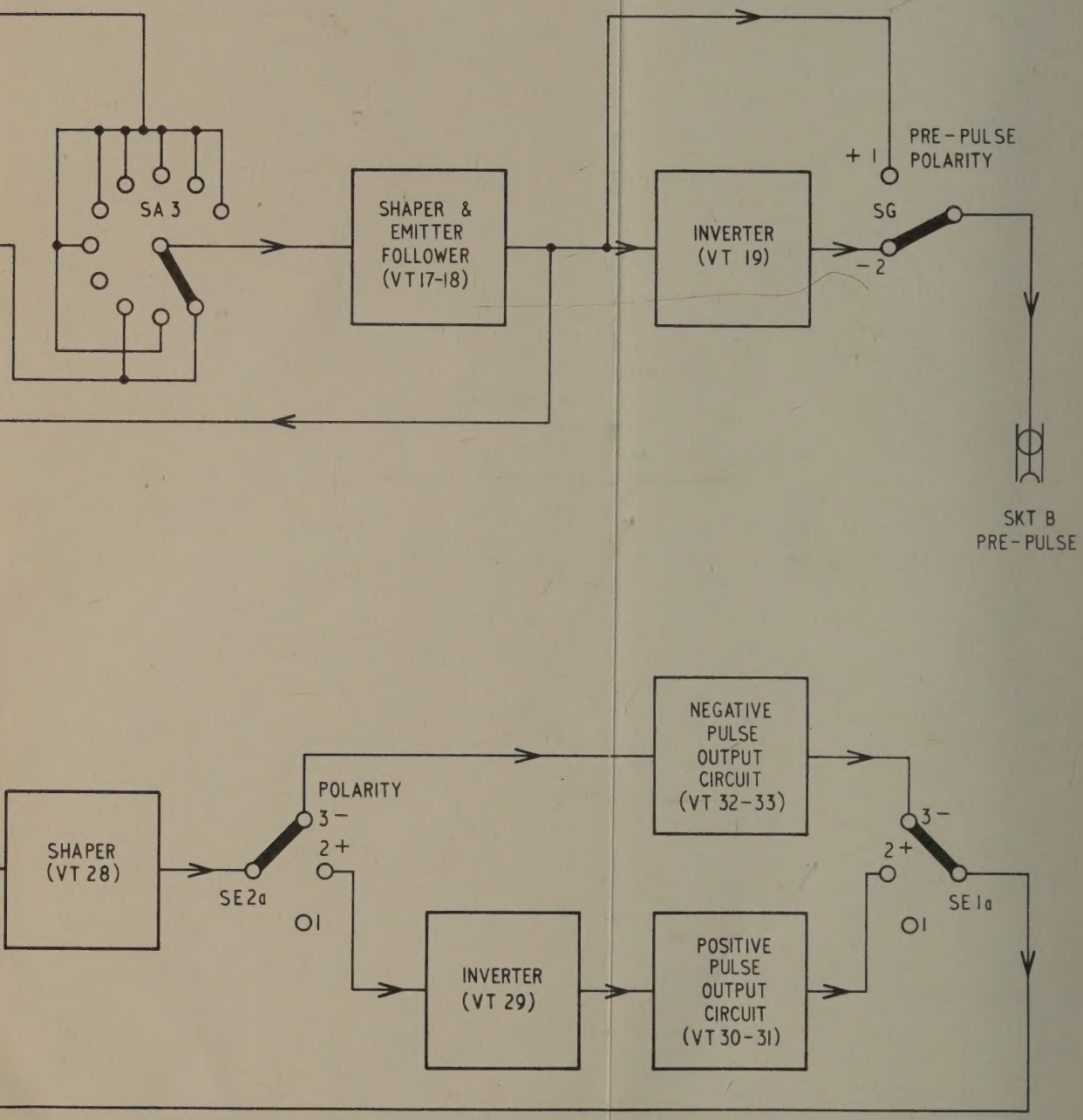
COPPER SIDE OF BOARD

FIG. 2

FIG.1 MAIN BOARD PIN POSITIONS
FIG.2 POWER SUPPLY BOARD PIN POSITIONS

DGM. NO. S63/53


OSCILLATOR
(VT 10-12)
SA 1
FREQUENCY
TRIGGER SWITCH
TRIGGER
CIRCUIT
(VT 13)
INVERTER
(VT 16)
SKT. A
EXT. INPUT
SH. MANUAL
INVERTER
(VT 21)
INVERTER
(VT 20)
DOUBLE
SINGLE
SF
MODE
SELECTOR
DELAY
CIRCUIT
(VT 22-23)
SHAPERS
(VT 24-25)
OR GATE
(R76, MR25 & 31)
WIDTH
CIRCUIT
(VT 26-27)
SKT. C
OUTPUT
ATTENUATOR



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BLOCK SCHEMATIC

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